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2

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NAVIGATOR COMMAND POTENTIAL: AN ANALYSIS OF U.S. AIR FORCE PILOT ATTITUDES TOWARD THE JOB SATISFACTION CHARACTERISTICS OF U.S. AIR FORCE NAVIGATORS

THESIS

James T. Denney, Jr., Major, USAF

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THESIS

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Master of Science in Systems Management

James T. Denney, Jr., B.A.

Major, USAF

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Preface

There are some who would classify the phrase "navigator command potential" as a contradiction in terms similar perhaps to "military intelligence." These same people might also question why anyone would survey pilots in a study of navigator job satisfaction characteristics and command potential. We could presume that all pilots have the same opinion on the subject or we could request their responses to a survey. My experience led me to believe that pilots do not have the same attitude about navigators or probably any other subject. This study supported that belief.

I would like to express my sincere thanks to my advisor, Dr. Kirk Vaughan, for his technical expertise and gentle demeanor. He is one of the most patient and tolerant pilots with whom I have ever had the pleasure to work. I am also grateful to Drs. Bob Steel, Guy Shane, and Ken Jennings for their insights into two subjects I can understand, leadership and organizational behavior. In addition, my heartfelt gratitude goes to a "knowledgeable statistician" and remarkable educator, Dr. Dan Reynolds. In spite of his best efforts, I may never fully understand statistics; but I will cherish the "Vee heuristic" and his philosophy toward learning for many years to come.

I would like to thank Col Bob Raggio, and the former commanders of the 4950th Test Wing with whom I served, for

recognizing the command potential in all of their personnel. It doesn't always take enormous responsibilities to promote command potential; yet even the shoes of the Task Force Commander can be difficult to fill at times.

There is one special group of people to whom I pledge my lifelong devotion. Most of us volunteer for the AFIT experience, fully aware of what to expect from it. I will be forever indebted to my wife, Sally, and our children, Beth, Johanna, Ty, and Daniel, for enduring this experience and having to live with me in the process. If I ever do anything like this again, I'll try to go TDY to do it.

Most importantly, I thank the Lord for allowing me to help Him accomplish this task. If it were not for His blessings, I would have given up long ago. As we set our priorities in this life, it helps to realize at least daily that if it were not for His grace and forgiveness, they would all be so meaningless (Matthew 6:33-34).

> And though he tried to look properly severe for his students, Fletcher Seagull suddenly saw them all as they really were, just for a moment, and he more than liked, he loved what it was he saw. No limits, Jonathan? he thought, and he smiled. His race to learn had begun.
>
> Richard Bach, 1970

Table of Contents

List of Figures

List of Tables

Abstract

This study analyzed the self-reported survey responses of 93 U.S. Air Force pilots concerning their perceptions of the command potential and job satisfaction characteristics of navigators. The first objective of this study was to compare the pilot responses with the results obtained from a previous Job Diagnostics Survey of Air Force navigators and Hackman and Oldham's normative data for professional workers. Differences in pilot attitudes were also compared with those of navigators based on the type of aircraft mission. The second objective was to compare responses based on the pilots' military rank and navigator supervisory experience. The third objective evaluated the pilot's opinion of the continued requirement for navigators in Air Force aircraft and of the ability of experienced navigators to perform as mission commanders. A command potential model was introduced to evaluate the third objective. Conclusions supported the differences in navigator job satisfaction based on aircraft mission. Results of the second and third objectives were inconclusive; although, navigator command potential and the continued need for navigators appear to be higher for tactical airlift and strategic bomber missions. Recommendations for further study and adaptation of the proposed command potential model were presented.

NAVIGATOR COMMAND POTENTIAL:

AN ANALYSIS OF U.S. AIR FORCE PILOT ATTITUDES

TOWARD THE JOB SATISFACTION CHARACTERISTICS

OF U.S. AIR FORCE NAVIGATORS

I. Introduction

One of the first questions that arises from a study of job satisfaction characteristics is, "Why study job satisfaction"? Perhaps the most important reason to study job satisfaction is that it directly affects productivity (16:105). Unfortunately, there is little agreement in the literature on what impact job satisfaction has on productivity.

> Job satisfaction can be thought of as a measure of the utility of the job toward reaching an individual's goals. Productivity on the other hand is a measure of the utility of the job toward reaching the organization's performance goals. Job satisfaction, therefore, will be related to productivity only so far as the organization's goals (as the individual perceives them) are congruent with the individual's goals. (46:4)

Several previous Air Force Institute of Technology (AFIT) studies have compared job satisfaction with the potential for the job redesign of certain career fields in the U.S. Air Force (9;13;17;25;46;50). Unfortunately, there have been few successful implementations of job redesign in the military (49:75).

General Issue

Historically, Air Force navigators have reported less satisfaction in their job than many of the other officer career fields. In 1986, Marchewka reported that job dissatisfaction among navigators was "probably because their jobs are declining in importance due to technology" (30:34). Fewer opportunities for career advancement when compared to pilots have also affected navigator job satisfaction. Recent developments in technology do not explain the advantage pilots have always had over navigators in obtaining command responsibilities. Only in the last sixteen years have navigators been afforded the same opportunities by law as pilots to command operational flying units (45:76).

A study by the Air Force Human Resources Laboratory (AFHRL) in 1972 recognized the impact of changing requirements on the navigator career field when it recommended a series of actions:

> The area of Navigator-Observer self concept requires examination with the objective of enhancing perceived self-actualization. As stated previously in this report, it is recommended that the anachronism "Navigator-Observer" be replaced with the role-related title of Flying Systems Officer. It also was suggested that the title "pilot" be replaced with the more role-related concept of Control Systems Officer. A study should be undertaken to examine the benefits which might arise from such changes in terms of enhancing the flying crew image and promoting perceptions of self-actualization. (39:27)

Obviously, the titles of "pilot" and "navigator" are still used today. The term "weapon systems officer" or WSO

is generally used for navigators in fighter aircraft because their specialized skills encompass more than navigation of the aircraft. The AFHRL recommendation for enhancing self-actualization in the navigator career field has been largely ignored and the extension of mission command responsibility to senior ranking navigators has never been instituted in U.S. Air Force aircraft. The AFHRL report pointed out in 1972 a fact that is valid even today: "The Navigator-Observer will not be totally replaced by sophisticated hardware systems, only assisted more by them" (39:6). Although advanced technology systems have replaced [illegible] need for navigators on the newer Air Force aircraft, budget reductions and life-extension modifications to older aircraft will ensure the requirement for navigators into the next century. Navigator retention problems similar to those of the mid-seventies could result if job redesign opportunities in the career field are not considered.

In 1985, Dotson and Hilbun studied the potential of job redesign for improving job satisfaction in the maintenance officer and navigator career fields of the Strategic Air Command (SAC). Although they concluded that the navigator career field within SAC was in need of redesign, Dotson and Hilbun could recommend only increased management responsibility in additional duties, unrelated to actual flying responsibilities, as a method of enhancing navigator job satisfaction (9:64). In a similar study in 1977, Krebs recommended that crewmembers provide more input into their

schedules for alert duty and leave (vacation) time as a method of redesigning their work (25:120). Both studies recognized that the rigid guidelines associated with the inflight duties of military crewmembers left little room for changes in work design that could result in significant increases in relative job satisfaction. Krebs hypothesized that because flight crew responsibilities are restricted by rules and regulations, "improvement in job satisfaction has to come through other areas, such as feedback from supervisors, security satisfaction, and through the rewards of the organization" (25:126).

In 1989, Urban expanded Dotson and Hilbun's research by investigating the job characteristics levels of all U.S. Air Force navigators and comparing them according to the type of aircraft and mission flown. Urban hypothesized that navigator job satisfaction varied in relation to the aircraft and its particular mission. As a result of his study, Urban concluded that not all navigators were in need of job redesign. Tanker and strategic airlift (C/KC-135 and C-141) navigators were identified as the most dissatisfied in the career field. Urban also identified autonomy, growth satisfaction, job security, and pay satisfaction as specific problem areas which affected all navigators (50:96,100).

Urban concluded that the problem of job autonomy for navigators stems from their "institutionalized" support role to pilots (50:97). Because navigators are prevented from assuming many leadership roles in their job, they have few

opportunities to make their own decisions. Urban's recommendation for a redesign of the career field addressed this area specifically. Not only is the pilot given the responsibility for the safe operation of the aircraft, but, by Air Force directive, the pilot is given the overall responsibility as mission commander. Urban asked, "why should the pilot always be in charge of all aspects of a mission simply because he/she controls the aircraft?" (50:105). One recommendation from Urban's study for possible navigator job redesign would defer the <u>mission</u> accomplishment responsibility to the senior-ranking rated officer (pilot or navigator) on the crew while allowing the pilot to maintain aircraft commander status as is common in U.S. Navy aircraft (50:105).

The problems in growth satisfaction and job security are similar in some respects. According to Urban, the navigator perception is that promotion opportunities to lieutenant colonel and above are better for pilots unless the navigator is willing to pursue a career path outside the operational flying area (50:97). This lack of promotion potential combined with a predicted decrease in overall navigator flying positions leads to a perceived job security problem.

The pay satisfaction problem that Urban identified was readily attributable to the pilot's continuation incentive bonus that went into effect in early 1989. Recent increases in flight pay for <u>all</u> rated officers with at least six years

flying experience may have decreased the impact of the pay disparity navigators had associated with the pilot's bonus.

Specific Problem

For additional research, Urban recommended an examination of the perceptions and attitudes of pilots toward the present and future role of the Air Force navigator (50:107). The specific problem is two-fold:

1. Do U.S. Air Force pilots perceive navigator job characteristics in the same manner as navigators?
2. Do pilots support mission command responsibility as a potential job redesign solution for navigators?

After an extensive literature search of the studies of job satisfaction within U.S. Air Force career fields, no previous research was found that investigated the perceptions by supervisors or co-workers of the job being studied. This point is significant because many of these previous studies used Hackman and Oldham's Job Characteristics Model in their analysis for job redesign (9;13;17;25;50). Hackman and Oldham readily admit that "work redesign is probably a bad idea if those who ultimately must support and diffuse the changes *believe* it to be a bad idea" (19:129).

Pilots, as well as other crewmembers in large, multi-place aircraft, are ideally situated to provide objective inputs concerning the job characteristics of the navigator career field. Pilots receive direct benefits from navigator

job performance. As the aircraft commander, a pilot should realize that improvements in the job satisfaction of any crew position could positively affect the overall performance of the entire flight crew.

From the navigator's perspective, decisions concerning the future of the navigator career field will probably be made by pilots more often than navigators. One can assume that navigators will have some degree of input into the future of their career field, but decisions of this magnitude are made at the general officer level. As of June 1990, all twelve of the four star generals in the Air Force were pilots. Of the 339 general officers currently assigned in the Air Force, 232 (68.4 percent) are pilots and eight (2.4 percent) are navigators (15). This current imbalance of aeronautical ratings among general officers is not an exception to the norm. In 1979, Talbot reported that while only 17 percent of the officer corps were pilots, 293 of 380 Air Force general officers were pilots and 18 were navigators (45:77).

In a situation similar to that reported in 1989, navigators again had the lowest promotion rate to lieutenant colonel among all Air Force line officers on the 1990 promotion board (50:103). The lack of command-related job opportunities may be the primary reason the second largest officer career field in the U.S. Air Force represents such a small percentage of the general officer corps.

Recent life-extension modifications to the C-135 aircraft fleet indicate the aircraft may be needed well into the next century. However, a current study within SAC, directed by HQ USAF, is evaluating whether the navigator position can be eliminated in the KC-135 Stratotanker (12).

The two navigator crew positions in the B-52 have been replaced by one Offensive Systems Operator in the B-1B, and currently only a two pilot crew is planned for the B-2. The traditional navigator requirement for a strategic bomber will be eliminated in the B-2 by training the right-seat pilot to perform as a dual-qualified mission commander <u>and</u> weapon systems officer (WSO) (1:26).

These navigator reductions do not include those reported by Urban which were primarily due to the retirement of many of the F/FB-111 fighter-bombers and the replacement of the F-4 fighter with the single-seat F-15 and F-16 aircraft (50:78).

During a period of austere defense budgets, manpower cutbacks are as much a reality as reductions in aircraft weapon systems. In fiscal year (FY) 1989, pilots comprised the largest officer career field in the U.S. Air Force with a total of 19,811, not including general officers or pilot training students (51:46). The second largest career field was navigators, totaling 8,375. The third and fourth largest officer career fields were communication/computer systems (6,499) and developmental engineering (5,887). It is obvious that navigators are vulnerable for manning

reductions. With a reduction in aircraft that require navigators, a larger percentage of reductions in navigator manning authorizations should be expected. Job security and growth satisfaction for all navigators may continue to be a problem area.

Since FY 1983, navigator retention has been the highest of any other officer career field in the Air Force (7:5). High retention is understandable because there is no comparable civilian career opportunity for navigators as there is for pilots. If a navigator desires to continue working in a flying career, there is no alternative but to remain in the military. A navigator, electing to separate from the military, has little experience from military service to carry forward into a civilian career.

A job redesign based on mission command responsibility for senior-ranking navigators would not necessarily improve the job security problem that Urban identified. Yet the potential for earlier command responsibility could improve problems associated with autonomy and growth satisfaction "as navigators experience more opportunities to make decisions and compete fairly for better positions" (50:106).

Research Objectives

If some degree of job redesign is to be initiated in the navigator career field, the logical sequence after surveying navigators (as Urban did) would be to obtain inputs about the career field from other sources. Such data

could serve at least two purposes:

> (a) it would pinpoint what characteristics of the job (if any) are viewed differently by different groups of respondents--thereby focusing attention on particularly unclear or otherwise troublesome aspects of the job; and
>
> (b) it would provide an indication of the overall degree of differential perceptions by employees and their supervisors. (18:34)

This study addresses three broad objectives. First, it reexamines the objectives of the 1985 and 1989 studies to investigate how Air Force pilots perceive the job satisfaction characteristics of the navigator career field.

Because differing opinions of navigator job characteristics may be held by more senior pilots, supervisors, and outside observers (non-supervisors) of the navigator career field, this study also analyzes the military experience (based on rank) and navigator supervisory experience of the respondents.

The third research objective of this study attempts to ascertain the pilot's perception of how well the navigator could perform as a mission commander. This objective was designed to answer the ultimate job redesign question: What potential does the navigator have for accepting the responsibility of successful mission accomplishment when the navigator is the senior and more experienced crewmember?

Investigative Questions

As did Dotson and Hilbun in their research, Urban used Hackman and Oldham's Job Diagnostics Survey (JDS) as the

survey instrument in his evaluation of the navigator career field (50:31). The Job Rating Form (JRF) is a companion questionnaire to the JDS survey instrument. Both the JDS and JRF were developed by Hackman and Oldham to measure job characteristics levels under their Job Characteristics Model (JCM). Unlike the JDS, which is administered to the individuals whose job is being studied, the JRF is designed to be administered to supervisors and outside observers of the job under consideration for redesign (18:7). The JCM, JDS, and JRF are explained thoroughly in Chapter II.

The following questions were designed to examine the three research objectives outlined above.

1. As indicated by the JRF, how do U.S. Air Force pilots perceive navigator motivation and job satisfaction characteristics compared to the JDS responses of U.S. Air Force navigators and the normative data for professional workers?
2. How does the pilot's overall military experience, determined by rank, and supervisory experience with navigators relate to whether a need for navigator job redesign is indicated in the results of the JRF data?
3. What is the pilot's perception of the value and continued requirement for the navigator career field? How does this value perception compare to the pilot's attitude toward surrendering mission commander responsibility to a more senior, experienced navigator?

Scope of the Research

The target population for this research consisted of all active duty U.S. Air Force pilots, with the rank of first lieutenant through major, currently assigned to flying status. To enhance the external validity of this research, no attempt was made to limit the population to only those pilots flying aircraft which required a navigator as part of the crew composition. Questions in the biographical information section of the questionnaire were designed to ascertain how much, if any, previous experience the respondents had in navigator-required aircraft. Because the questionnaire was designed for supervisors or outside observers having some familiarity with the job in question, responses returned by pilots who had no previous experience flying with navigators were not used.

This study did not include pilots in staff positions because, as indicated in Urban's research, it was preferable to have the perceptions of those pilots whose primary duty was flying instead of those pilots who shared flying duties with staff support activities (50:6). The experience levels of pilots with the rank of first lieutenant through major were chosen also to match those examined in Urban's study.

This research design went one step further than Urban's in that the only potential job redesign available for navigators, in the author's opinion, was pursued as the third research objective. Additional questions were added, in a third section of the survey questionnaire, which were

used to analyze the respondent's perception of navigator mission command potential. The survey questionnaire will be discussed in Chapter III. No other job redesign opportunities were investigated because, as cited previously in the research by Krebs, and Dotson and Hilbun, flight crew responsibilities are restricted by rules and regulations that inhibit changes to work design.

Limitations of the Research

As in any research effort, there are certain limitations which cannot be overcome. The vast collection of literature associated with this type of research is one limitation to this study. The literature has been reviewed extensively to investigate all theories associated with the study of job satisfaction. However, hundreds of lesser known investigations may have been done in various areas of job redesign which may not have received the same degree of attention as those published in the professional periodicals. A review of the literature applicable for this study is contained in Chapter II.

The use of a survey questionnaire for this research has certain inherent weaknesses. First, the accuracy of the information obtained is dependent on the knowledge and cooperation of the respondents (11:159). This point would be applicable if the responses of pilots who have never flown with navigators were used. A respondent may not know

the answer to a particular question but may attempt to help the research by guessing at an answer.

A second limitation to the survey questionnaire is the type and amount of information that can be received from it. Detailed explanations are difficult to obtain when using a questionnaire with a limited number of questions (11:173). Use of a seven-point Likert scale in answering the JRF permits some degree of flexibility in the respondent's choice of answers. In addition, allowing the respondent to add comments at the end of the questionnaire permits some degree of emphasis and subjectivity in the responses.

One final limitation of a survey questionnaire is the problem associated with "self-report" biases:

> Rather than collecting data about behavior itself, the questionnaire collects individuals' reports of behavior, and these reports may be biased (consciously or unconsciously) by the respondent. These biases may include such things as a tendency to answer questions that are next to each other in a similar manner, and a tendency to answer questions later in the questionnaire with less care than earlier questions. (33:253)

The use of a relatively short questionnaire and the importance of the subject area may have encouraged accurate responses. However, as with any single data collection tool, Nadler warns, "the results should be validated and used with care, rather than always being accepted at face value" (33:251).

Summary

This chapter has presented an overview of the objectives of this research effort. The general issue of

job satisfaction in the military environment was covered. Specific problems associated with previous AFIT job redesign studies of the navigator career field were addressed along with the research objectives for this study. Investigative questions designed to answer the research objectives were provided along with the scope and limitations of this research. Chapter II will define some of the important terms and introduce specific job redesign models and theories applicable to this particular research.

II. Background

This chapter addresses three aspects of the research. First, definitions are provided for some of the important terms used in the discussion of job redesign. Second, a literature review of previous research in the areas of motivation and job redesign theory is presented. And finally, the models used in this study are introduced.

Definitions

Thompson has defined job satisfaction as "a measure of an individual's perception of how well his needs are met by his job and its related environment" (46:12). This measure of job satisfaction is not objective but is based instead on how one perceives that needs are being met. In addition, job satisfaction is related not only to one's perception of the job but also to the job environment.

Robbins has defined perception as "a process by which individuals organize and interpret their sensory impressions in order to give meaning to their environment" (37:17). Seldom do two or more people look at something and perceive it in the same way. One's perceptions can be affected by past experiences, interests, attitudes, expectations, or external influences, such as the environment.

According to Robbins, job satisfaction is simply one's "general attitude" toward a job. Positive attitudes usually

reflect a great deal of job satisfaction while negative attitudes indicate some degree of job dissatisfaction. Many people perceive job attitude to be equivalent to job satisfaction (37:11).

Steers has defined attitude as "a predisposition to respond in a favorable or unfavorable way to objects or persons in one's environment" (43:283). Steers bases this definition on three assumptions:

> 1. An attitude, such as job satisfaction, is a hypothetical construct; that is, while the consequences of an attitude may be observed, the attitude itself cannot.
>
> 2. An attitude is a unidimensional variable. That is, an attitude toward a particular person or object ranges on a continuum from very favorable to very unfavorable.
>
> 3. Attitudes are believed to be related to subsequent behavior. The definition of attitude implies that people behave based on how they feel. (43:283-284)

Job redesign refers to the process of making a job more interesting in order to increase the "quality of an employee's work experience and on-the-job productivity" (37:46). One common approach for job redesign is through job enrichment. Job enrichment pertains to increasing the depth of a job by expanding it vertically. This expansion permits the worker to control more of how the job is accomplished and "attempts to make the job more interesting, challenging, and significant by adding dimensions such as variety, autonomy, feedback, and control" (48:379).

Literature Review

As discussed in the previous chapter, one of the limitations of this study is the enormous amount of prior research that has been accomplished in the area of job satisfaction. This chapter will review only a portion of the literature pertinent to this specific study. Of particular interest are some areas of the literature which were not reviewed by Urban or Dotson and Hilbun in their research. For a more complete review, encompassing a broader approach to job design, the reader may wish to refer to Talbot's 1979 study (45).

Motivation to Perform. Steers presents a comprehensive definition of motivation as "that which energizes, directs, and sustains human behavior" (43:151). Motivation drives people to behave as they do; it is usually goal-directed and part of an overall systems process. This motivational process has been described as the following continuous cycle of events:

> 1. Inner state of disequilibrium: need, desire, or expectation, accompanied by anticipation.
>
> 2. Behavior or action.
>
> 3. Incentive or goal.
>
> 4. Feedback, followed by reassessment and possible modification of the inner state. (43:153)

The Cognitive Model. This current psychological understanding of motivational behavior replaced the

reinforcement, or drive, theory in the 1940s. The cognitive model assumes that individuals make conscious decisions about their behavior as opposed to reacting to external stimuli in an acognitive manner. Lewin and Tolman were among the earliest researchers to develop the view that individuals are "thinking, rational beings who make conscious decisions about their present and future behavior based on what they believe will happen" (43:158).

One popular format for discussing the various motivational theories is to divide them into the two classes of "content" and "process" theories. According to Landy, content theories attempt to explain what is within an individual that energizes, directs, sustains, and ends certain behavior. Process theories, on the other hand, attempt to explain <u>how</u> an individual's behavior is energized, directed, sustained, or stopped (26:318). Two of the widely-accepted process theories are expectancy, sometimes referred to as instrumentality theory, and equity theory. Before discussing the process theories of motivation, a review of the more basic need theories is warranted.

<u>Maslow's Need Hierarchy and ERG Theory</u>. According to Maslow, human motivation can be explained in terms of the various needs that individuals are constantly experiencing (31:102). A need that remains unsatisfied creates tension, acts to energize the human system, and eventually provides

direction. This purposeful energy guides the individual toward some goal that will respond to the unsatisfied need. Maslow defined motivation as the process of an unsatisfied need providing energy and direction toward a specific goal (4:210). Therefore, only unsatisfied needs provide the sources of motivation. Satisfied needs are not motivating because no tension has been created.

Maslow identified five levels of needs, arranged in a hierarchy, beginning with the basic physiological needs and continuing on to the highest self-actualization needs. These five needs have been defined as:

1. Physiological. The need for food, drink, shelter, and relief from pain.

2. Safety and security. The need for freedom from threat, that is, the security from threatening events or surroundings.

3. Belongingness, social and love. The need for friendship, affiliation, interaction, and love.

4. Esteem. The need for self-esteem and for esteem from others.

5. Self-actualization. The need to fulfill oneself by making maximum use of abilities, skills, and potential. (23:109)

An important characteristic of Maslow's theory is that at any given time the more basic unsatisfied need is the most important. An individual will not move up the hierarchy to the next higher need until the lower need is satisfied (26:319). This characteristic is one of the primary criticisms against Maslow's theory. A theory proposed by Alderfer recognizes that the importance of a

need in the hierarchy depends on the amount of satisfaction one has with the needs above and below it (27:29).

Alderfer's existence, relatedness, growth (ERG) theory has become increasingly more accepted primarily because of the difficulty in validating Maslow's theory empirically (43:164).

> Maslow's model may be expressed as one of "fulfillment-progression"--that is, an individual must satisfy one level of need before moving on to the next highest level. In addition to the "fulfillment-progression" component, Alderfer has added a "frustration-regression" component. Alderfer assumes that existence, relatedness, and growth vary on a continuum of concreteness, with existence needs being the most concrete, relatedness needs being moderately concrete, and the growth need being the least concrete. He further assumes that when the less concrete needs are not met, more concrete need fulfillment is sought. (26:323)

Figure 1 illustrates the comparison of these two need hierarchy theories. Alderfer recognized some ambiguities between Maslow's five categories of needs (2:24). Maslow actually described two types of safety needs, according to Alderfer. The first type of need was for protection from physical illness and pain, while the other was a more personal need for protection from such things as family outbursts or speaking harsh words. Therefore, Alderfer divided Maslow's safety category between the existence and relatedness needs of the ERG theory.

In a similar manner, Alderfer recognized that Maslow defined two different types of esteem: the need for esteem from others and self-fulfilling esteem. Alderfer separated

these two types of esteem needs into his relatedness and growth needs as is indicated in Figure 1 (2:26).

Maslow Categories	ERG Categories
Physiological	Existence
Safety-material	
Safety-interpersonal	Relatedness
Love (Belongingness)	
Esteem--interpersonal	
Esteem--self-confirmed	Growth
Self-actualization	

Figure 1. Comparison of Maslow and ERG Concepts. (2:25)

Alderfer's ERG theory has been described as being less rigid, allowing for more flexibility when describing human behavior (43:164).

<u>Herzberg's Motivator-Hygiene Theory</u>. A study reported by Frederick Herzberg and his colleagues in 1959 pointed out that man is influenced by two kinds of needs at the same time (21:113). Herzberg related his theory more to job satisfaction than human motivation when he proposed his Motivator-Hygiene, or Two-Factor Theory. Herzberg argued

that only the objects associated with Maslow's higher order needs of esteem and self-actualization provide satisfaction on the job (4:210). These satisfiers or "motivators" represent the intrinsic rewards (recognition, opportunity for promotion, and growth potential) of the job (21:113). The fulfillment of lower order needs reduces only the dissatisfaction one has with the job. These dissatisfiers or "hygiene factors" are the extrinsic rewards (salary, job security, and working conditions) of the job.

As did Maslow, Herzberg received various criticisms of his theory. Vroom found fault with the critical-incident methodology, in which the individual recounts extremely satisfying and dissatisfying events of the job.

> Persons may be more likely to attribute the causes of satisfaction to their own achievements and accomplishments on the job. On the other hand, they may be more likely to attribute their dissatisfactions not to personal inadequacies of deficiencies, but to factors in the work environment; i.e., obstacles presented by the company policies or supervision. (52:129)

Besides being methodology bound, the Two-Factor theory was also criticized for faulty research and inconsistency with previous theories. However, by proposing that job satisfaction could best be obtained by increasing the "motivator" factors instead of increasing the "hygiene" factors, Herzberg laid the groundwork for most the job redesign work that has followed (26:325).

Herzberg led most of the job redesign efforts in the Air Force in the mid-seventies (21). His work with Major

General Edmund Rafalko at the Ogden Air Logistics Center in 1974 was responsible for a $1.75 million savings on 29 projects over a two year period. The savings was attributed to "reduced sick leave, a lower rate of personnel turnover, less overtime and rework, a reduction in man-hours, and material savings" (20:24).

By 1979, Air Force Logistics Command (AFLC) had 376 job enrichment programs in progress. Similar programs were undertaken in SAC and the Tactical Air Command (TAC) which showed improvements in morale and reduced absenteeism, but were not as impressive as the AFLC studies. In 1980 Umstot noted that, although Herzberg's theory was useful as a framework for job redesign studies, "a more recent model developed by J. Richard Hackman and Greg Oldham may be even more useful to Air Force managers" (49:75). Umstot was referring to Hackman and Oldham's Job Characteristics Model.

Equity Theory of Motivation. Perhaps one of the more easily understood motivation theories, equity theory is based on two assumptions about behavior. One is that individuals view their social relationships as an exchange process where certain outcomes are expected in return for their contributions of efforts. And two, individuals assess the equity of this exchange process by comparing their situation with that of "referent" others to determine a relative balance. (43:185-188)

Equity comparison is the essence of the navigator pay satisfaction issue which Urban identified as a result of the pilot's continuation bonus introduced by the Air Force in 1989.

> Equity exists when employees perceive that the ratios of their inputs (efforts) to their outcomes (rewards) are equivalent to the ratios of other employees. Inequity exists when these ratios are not equivalent; an individual's own ratio of inputs to outcomes could be greater than, or less than, that of others. (23:118)

Urban reported that 84 percent of his survey group perceived the inequity as a deterrent to crew integrity and as "a major source of negative feelings among Air Force navigators due to the perception of unfairness associated with the recently created pilot incentive bonus" (50:97).

The implication of perceived inequity is that it creates tension. As shown in Figure 2, the tension experienced by individuals motivates them to attempt to reduce it (43:187). The degree of motivation or desire to reduce the tension is proportional to the amount of the perceived inequity.

Another important implication of equity theory is the alternatives that an individual may use in order to restore a feeling of equity when an unequitable situation is perceived to exist (23:118-119). An individual might change the level of input to the job in proportion to the magnitude of the inequity. Another alternative would be to distort the level of output or input by deciding that other rewards

offset a pay inequity or that the individual's level of input does not equal that of the referent other after all.

→ Perceived inequity → Tension within individual → Motivation to reduce tension → Behavior →

Figure 2. Motivational Implications of Perceived Inequity. (43:188)

A final alternative would be to change the ratio of comparison to another individual within the workplace or, more commonly, to leave the job and go to another workplace.

> Equity theory attaches much importance to monetary rewards and the manner in which they are distributed. Money is one of the few rewards that people clearly see and measure. As a result, it often becomes a major focal point in employee assessments about their own equity. (43:191)

Monetary rewards are not the only outcomes to be considered in equity theory. Respect within the organization, increased promotion opportunities, and high self-esteem are some of the other rewards that can add to perceptions of equity. Apparently navigators perceive that an inequitable amount of non-monetary rewards is also given to pilots in the flying organization. As Urban noted in his analysis of navigator growth satisfaction, "navigators feel that the only way to obtain growth and increased responsibility is to seek opportunities outside of operational flying units" (50:103).

Expectancy Theory. One of the most comprehensive process theories yet proposed, expectancy theory, was first introduced by Tolman and Lewin in the 1930s. The basic premise proposed by each of these psychologists was that individuals have "expectations" or "anticipations" concerning future events. Tolman first argued for an approach to the study of behavior that was more cognitively oriented. Because of Lewin's approach to a cognitive explanation of behavior, several variations of expectancy theory have been proposed (36:9). Instrumentality, path-goal, and Vroom's VIE (valence-instrumentality-expectancy) theory include the concept of valence, or the attractiveness of an outcome, and expectancy, "the likelihood that an action will lead to a certain outcome or goal" (27:45). Before attempting to predict an individual's behavior, one must know the attractiveness of the possible outcomes available to the individual. In addition, one must know if factors other than attractiveness are influencing an individual's choice for an outcome (27:41).

Obviously not as simple a concept as equity theory, expectancy theory is best explained using these three concepts:

> Performance-Outcome Expectancy. Every behavior has associated with it, in an individual's mind, certain outcomes (rewards or punishments). In other words, the individual believes or expects that if he or she behaves in a certain way, he or she will get certain things.
>
> Valence. Each outcome has a "valence" (value, worth, attractiveness) to a specific individual. Outcomes have

different valences for different individuals. This comes about because valences result from individual needs and perceptions, which differ because they in turn reflect other factors in the individual's life.

Effort-Performance Expectancy. Each behavior also has associated with it in the individual's mind a certain expectancy or probability of success. This expectancy represents the individual's perception of how hard it will be to achieve such behavior and the probability of his or her successful achievement of that behavior. (34:68)

More than one type of outcome is identified in expectancy theory (23:116). "First-level" outcomes are those which result from actually doing the job, such as productivity, absenteeism, quality, and turnover. "Second-level" outcomes represent the expected results (rewards or punishment) to be gained from the first-level outcomes, such as promotions and group acceptance or rejection.

Figure 3 illustrates the association between the two types of expectancy and the first and second-level outcomes that is represented by the expectancy model. As indicated in the illustration, the outcomes (first or second-level) may be intrinsic or extrinsic. The valence associated with each outcome is not represented but, according to the theory, must be considered before any effort is expended.

Valence-Instrumentality-Expectancy Theory. Victor Vroom was the first to adapt expectancy theory for the study of work motivation (27:45). Vroom hypothesized:

> Job satisfaction must be assumed to be the result of the operation of both situational and personality variables. It is only through the simultaneous study of these two sets of factors that the complex nature of their interactions can be revealed. (52:173)

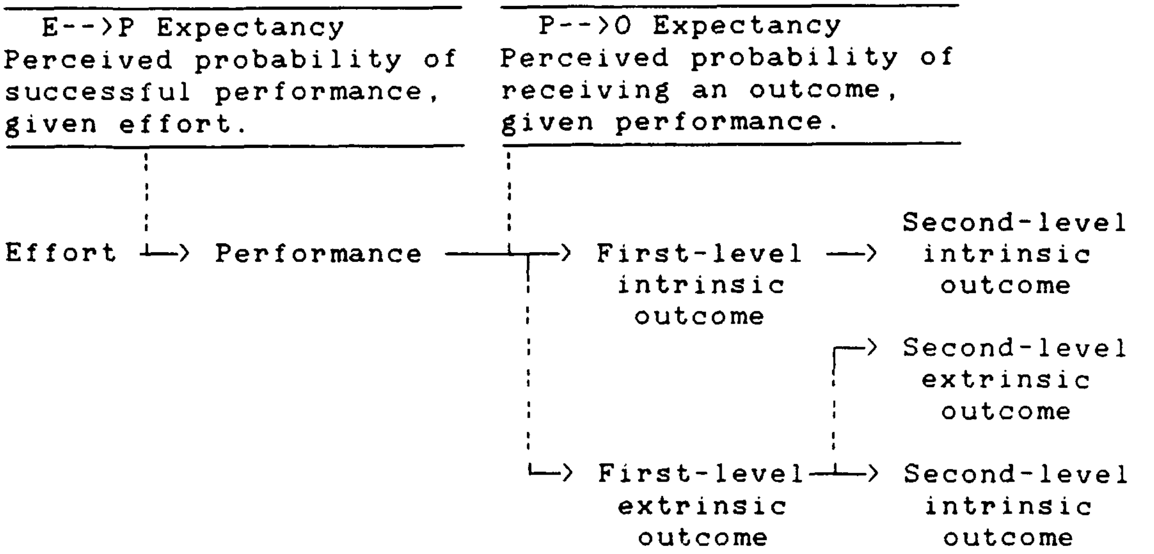


Figure 3. Illustration of the Expectancy Model. (34:74)

Vroom differentiated <u>valence</u>, the "affective orientations toward outcomes," from <u>need</u>, "the strength of desires or aversions for large classes of outcomes" (52:15). In addition, Vroom proposed that valence could be neutral or have a wide range of positive or negative values. When an individual prefers to attain an outcome, the valence would be positive. A neutral or zero valence would reflect an individual's indifference to attaining an outcome. While a negative valence would indicate a preference not to attain an outcome. Vroom also emphasized that one's behavior is affected by how probable one believes the preferred outcomes are likely to occur. This belief in a likely occurrence describes Vroom's definition of "expectancy" (52:17).

Lawler further explains the relationship of valence and expectancy:

> Vroom's theory argues for multiplying the valence (V) of each outcome times the strength of the expectancy (E) that the act will lead to the attainment of the outcome and then taking the algebraic sum of all the resulting products. Thus, he writes his theory as follows:
>
> $$\text{Force} = \Sigma(E \times V),$$
>
> where Σ means that the products for all outcomes are added to determine force. (27:46)

The "force" variable in Vroom's formula refers to Lewin's <u>driving</u> force, or "determinative of the behavior," which is Lewin's explanation of <u>motivation</u> (29:81).

The multiplicative relationship between expectancy and valence means that both must be present in order to achieve motivation. Simply placing a high value on an outcome will not motivate people unless they also believe the outcome is obtainable through their personal efforts (4:212).

Instrumentality is the third variable in Vroom's theory. It refers to the "degree to which the person sees the outcome in question as leading to the attainment of other (second-level) outcomes" (45:29). Expectancy is considered as a probability that can be any value from zero to one but instrumentality can represent any value from -1 (the second outcome is certain without the first outcome but impossible with it) to +1 (the second outcome requires the attainment of the first outcome) (45:29).

An important point in Vroom's theory is the vast difference which may exist between one's anticipated satisfaction from an outcome (valence) and the actual satisfaction, or value, that the outcome provides (5:21).

This differentiation between the value and valence of an outcome can be shown in the navigator's expectancy for career progression. To fly as a rated officer in the U.S. Air Force has a certain appeal to many young navigators. The option to train to be a pilot may or may not have been available. Poor vision is a common factor in choosing navigator training instead of pilot training. Regardless of whether they actually wanted to be pilots, navigators soon realize that the value they receive from an Air Force flying career does not always equal the valence they originally associated with that career. Other than the obvious effect this disparity has on the navigator's morale, a lack of commitment to the Air Force mission and poor job performance are the more serious problems which may result.

Although complicated at first glance, expectancy theory is based on common sense and has implications for job redesign and reward systems. Most research today supports expectancy theory by showing "that high-performing employees believe that their behavior, or performance, leads to rewards that they desire" (4:212).

<u>Porter and Lawler's Model</u>. Drive theory, in addition to expectancy theory, was considered as a beginning

point for Porter and Lawler's job satisfaction model. As Lawler explained, "Both postulate learned connections with outcomes and include the notion of a favorable outcome that is desired" (27:47). However, drive theory was not used in Porter and Lawler's model because it emphasizes only the importance of the stimulus-response connection instead of the more important "forward-looking" beliefs of expectancy theory (27:47).

Porter and Lawler also used equity theory to explain the relationship between job satisfaction and productivity in their model. Job satisfaction is a result of the rewards that workers receive or expect to receive from the performance of their jobs. The amount of an individual's productivity in the job is often dependent on the expectation of the amount of the rewards (16:108).

Porter and Lawler proposed that because of this interaction between performance and rewards, and rewards and job satisfaction, the premise that job satisfaction affects productivity must be reversed. According to Porter and Lawler, expectancy theory tends to support the hypothesis that productivity affects job satisfaction (36:38). The relationship of job performance to job satisfaction in Porter and Lawler's model is illustrated in Figure 4.

Porter and Lawler's explanation of the perceived equity of rewards is evident in the navigator career field. Not only is the job satisfaction of navigators affected by their perception of inequity with pilots, but their efforts to

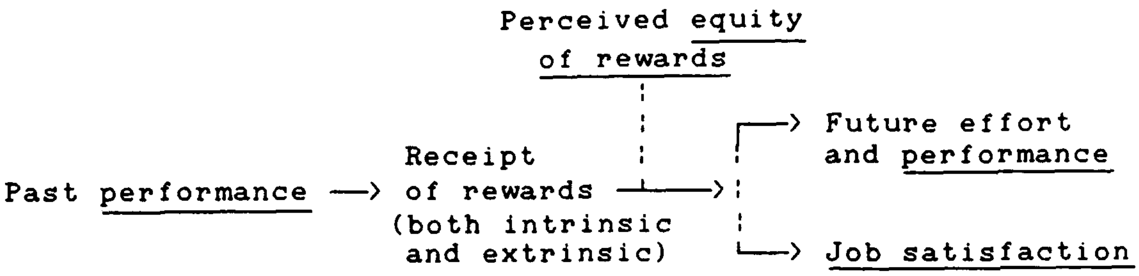


Figure 4. Relationship of Performance to Job Satisfaction in Porter and Lawler's Model. (43:306)

improve performance may also be discouraged. As Urban pointed out, a navigator who desires opportunities for career advancement will soon realize that a flying career is not the best way to earn promotions (50:103). Career incentives for navigators who wish to remain in flying assignments are practically non-existent.

Models of Job Characteristics. Turner and Lawrence are given credit for being among the first to propose that jobs have certain characteristics, or Requisite Task Attributes (RTA). The RTAs are: variety, autonomy, required interaction, knowledge and skill required, and responsibility (47:19-30). Turner and Lawrence theorized that these RTA characteristics, which enhance the intrinsic nature of the job, result in increased satisfaction and less absenteeism from the job (45:33). When studies of rural and city workers failed to reflect the relationship that was expected between the RTA and job satisfaction, Turner and Lawrence found that while job enrichment was important to

the rural worker, workers in the city preferred to remain in jobs requiring only simple tasks (47:69-90).

Basing their work on the model of RTA characteristics, Hackman and Lawler recognized the discrepancy between city and rural workers as an indication that all workers do not desire job enrichment. As Lawler noted, "job enrichment will be effective only if employees value such higher-order needs as achievement, competence, and personal growth" (28:88). Hackman and Lawler modified the original six RTA characteristics as follows:

> Variety. The degree to which a job requires employees to perform a wide range of operations in their work and/or the degree to which employees must use a variety of equipment and procedures in their work.
>
> Autonomy. The extent to which employees have a major say in scheduling their work, selecting the equipment they will use, and deciding on procedures to be followed.
>
> Task identity. The extent to which employees do an entire or whole piece of work and can clearly identify with the results of their efforts.
>
> Feedback. The degree to which employees, as they are working, receive information that reveals how well they are performing on the job.
>
> Dealing with others. The degree to which a job requires employees to deal with other people to complete their work.
>
> Friendship opportunities. The degree to which a job allows employees to talk with one another on the job and to establish informal relationships with other employees at work. (40:197)

Rather than simply expanding a job vertically as Herzberg had proposed, Hackman and Lawler's model proposed both vertical and horizontal job enrichment. Task identity,

variety, and feedback are examples of an individual's perception of job range--horizontal enrichment. Autonomy represents perceptions of vertical enrichment while perceptions of job relationships are represented by dealing with others and friendship opportunities. If workers have different perceptions of these characteristics, they will report different levels of job satisfaction, even though they may work in the same job (23:534).

The Job Characteristics Model. Drawing from both the early need theories, expectancy theory, and earlier job characteristics models, the Job Characteristics Model (JCM) focuses on the relationship of the satisfaction of the worker and the design of the job. Although the results are similar to Herzberg's job enrichment plan, the JCM provides broader implications for job redesign (4:212). Hackman and Oldham proposed five core job dimensions as further revisions to Hackman and Lawler's six job characteristics:

> Skill Variety. The degree to which a job requires a variety of different activities in carrying out the work, which involve the use of a number of different skills and talents of the employee.
>
> Task Identity. The degree to which a job requires completion of a "whole" and identifiable piece of work --i.e., doing a job from beginning to end with a visible outcome.
>
> Task Significance. The degree to which the job has a substantial impact on the lives or work of other people--whether in the immediate organization or the external environment.
>
> Autonomy. The degree to which the job provides substantial freedom, independence, and discretion to

the employee in scheduling the work and in determining the procedures to be used in carrying it out.

Feedback from the Job Itself. The degree to which carrying out the work activities required by the job results in the employee obtaining direct and clear information about the effectiveness of his or her performance. (18:5)

According to the JCM, the following three key conditions, or "critical psychological states" must exist in the worker before strong internal motivation will develop and persist:

Experienced Meaningfulness of the Work. The degree to which the employee experiences the job as one which is generally meaningful, valuable, and worthwhile.

Experienced Responsibility for Work Design. The degree to which the employee feels personally accountable and responsible for the results of the work he or she does.

Knowledge of Results. The degree to which the employee knows and understands, on a continuous basis, how effectively he or she is performing the job. (18:72-73)

Hackman and Oldham propose that when the above states are evident in the job, the employee will be satisfied with the job and perform better (19:78-80). The five core job dimensions influence the critical psychological states in the following manner. Skill variety, task identity, and task significance affect horizontal job enrichment and influence the meaningfulness of the job. Autonomy affects the depth or vertical enrichment and influences the job's responsibility for outcomes. Job feedback influences the knowledge of the job's actual results.

Realizing that any one job may not be perceived as high or low in all the five core job dimensions, Hackman and

Oldham proposed "a single index that reflects the overall potential of a job to foster internal work motivation on the part of the job incumbents" (19:81). When numerical scores are available for these five core dimensions, they are used in computing the Motivating Potential Score (MPS):

$$\text{MPS} = \frac{\text{Skill variety} + \text{Task identity} + \text{Task significance}}{3} \times \text{Autonomy} \times \text{Job feedback}$$

In the above formula, it is apparent that autonomy and job feedback are multiplicative factors which have a greater impact on the MPS than any of the other three core job dimensions. This fact is supported by the JCM because both experienced responsibility and knowledge of results must be present in the job if internal work motivation is to be high (19:80-81). Autonomy and job feedback represent these two critical states. Experienced meaningfulness is represented by skill variety, task identity, and task significance. The additive factor of these three job dimensions in the MPS formula reflects the lesser significance of a low score in one or two of these measures for the experienced meaningfulness state.

As noted in the earlier job characteristics models, certain "moderating effects" may be evident in an individual's perception of a job's characteristics. Turner and Lawrence pointed out that city workers were not as likely to desire job enrichment as rural workers. A psychological need for enrichment must be evident before any job redesign may be successful. Hackman and Oldham refer to

an individual's "growth need strength" to explain this psychological need (19:85).

Two other "moderators" which Hackman and Oldham propose as being influential in job redesign are knowledge and skill, and satisfaction with the work _context_ (19:82). Herzberg and Vroom each pointed out that first the worker must have the _ability_ to perform the task before job enrichment could take place. Hackman and Oldham further propose that the worker must also enjoy the context of the job and the job environment (supervisor and co-workers) before any enrichment will be effective (19:86).

The Job Diagnostic Survey. The JCM is primarily intended to be used in planning and implementing changes to the design of specific jobs. The Job Diagnostic Survey (JDS) is the primary tool Hackman and Oldham provided to implement the procedures and change principles outlined in their JCM (19:103). However, the JDS is just a part of a "multiple-method" procedure. Evaluation of jobs before and after redesign to assess the effects on worker motivation and satisfaction is the primary purpose of the JDS. Although the JDS is designed to measure nineteen variables associated with the JCM, it does not measure the variables of job knowledge and skill or work effectiveness. According to Hackman and Oldham, "These factors are idiosyncratic to particular work settings, and therefore defy meaningful measurement across organizations" (19:103).

Two additional job dimensions, not contained in the JCM, which Hackman and Oldham found beneficial in the study of job redesign, are measured by the JDS. They are:

> Feedback from Agents. The degree to which the employee receives clear information about his of her performance from supervisors of from co-workers.
>
> Dealing with Others. The degree to which the job requires the employee to work closely with other people in carrying out the work activities (including dealings with other organization members and with external organizational "clients".) (18:5)

These supplemental job dimensions are derived from the earlier models and measure the relationships that the job has with others. Hackman and Oldham propose that these dimensions are useful in determining if a set of jobs may need to be evaluated for potential redesign (19:103).

In addition to measuring for the seven job dimensions and work outcomes (represented by the three critical psychological states), the JDS also measures a number of "personal outcomes" that the worker derives from performing the job. These personal outcomes or "affective reactions" are:

> General Satisfaction. An overall measure of the degree to which the employee is satisfied and happy with the job.
>
> Specific Satisfactions. A number of short scales which provide separate measures of satisfaction with:
> (a) job security
> (b) pay and other compensation
> (c) peers and co-workers ("social" satisfaction)
> (d) supervision
> (e) opportunities for personal growth and development on the job ("growth" satisfaction)

Internal Work Motivation. The degree to which the employee is self-motivated to perform effectively on the job.

Individual Growth Need Strength. An individual characteristic predicted to affect how positively an employee will respond to a job with objectively high motivating potential. (18:6)

The Job Rating Form. The personal outcome measurements, along with the work outcome measurements of the three psychological states, are the primary differences the JDS has over its companion survey, the Job Rating Form (JRF). The JRF is designed to be administered to supervisors and outside observers (co-workers) of the job under consideration. Because the measurements of outcomes are dependent on the individual perceptions of the worker, the JRF consists of only the first two sections of the five-part JDS. These two sections are designed to measure only the job dimensions and the MPS. By making slight changes to the wording of the JDS questions, the JRF "permits direct quantitative comparisons to be made between assessments of job characteristics by the people who do the job, by their supervisors, and by outside observers" (18:28).

The JRF is also an integral part of the "multiple-method" diagnosis of the JCM. Before initiating job redesign, Hackman and Oldham warn that "because profiles of job characteristics are critical in identifying those aspects of a job that most need change, it is not advisable to rely _solely_ on employee data in constructing them" (19:114). Figure 5 depicts the typical _shapes_ of the job

characteristic profiles of a hypothetical job as indicated by the worker and the supervisor/co-worker.

> When the shapes of the two profiles are similar, as in part (a), then planning for change can proceed with little reason for concern. When, however, employees and supervisors disagree about what are the relatively best and worst aspects of the job, as in part (b) of the figure, then additional data are required before planning for change proceeds. (Frequently the views of the outside observers fit well with either those of the employees or those of the supervisors.) (19:115)

Criticism of the JCM. Other researchers have been especially critical of the lack of validity of the JDS measuring scales. Hackman and Oldham recognized that method variance was a potential problem particularly when measuring the context satisfactions and growth need strength (GNS). The Job Descriptive Index, a more proven measure of job satisfaction, was recommended when "highly trustworthy" measures were needed (19:314).

According to Roberts and Glick, many of the problems associated with "exploratory" job design studies are still prevalent in the job characteristics approach:

> The use of job classifications from existing organizational documents having unknown validity, the measurement of several distinct job characteristics with multiple indicators for each characteristic but the arbitrary combination of these characteristics into a unidimensional job description, the use of this unidimensional job description as the sole descriptor of tasks, the failure to indicate the interitem reliability of the unidimensional scale, and the failure to contrast competing explanations in a single study. (38:198)

The JCM has received other criticisms in the use of five core job dimensions to represent the unidimensional

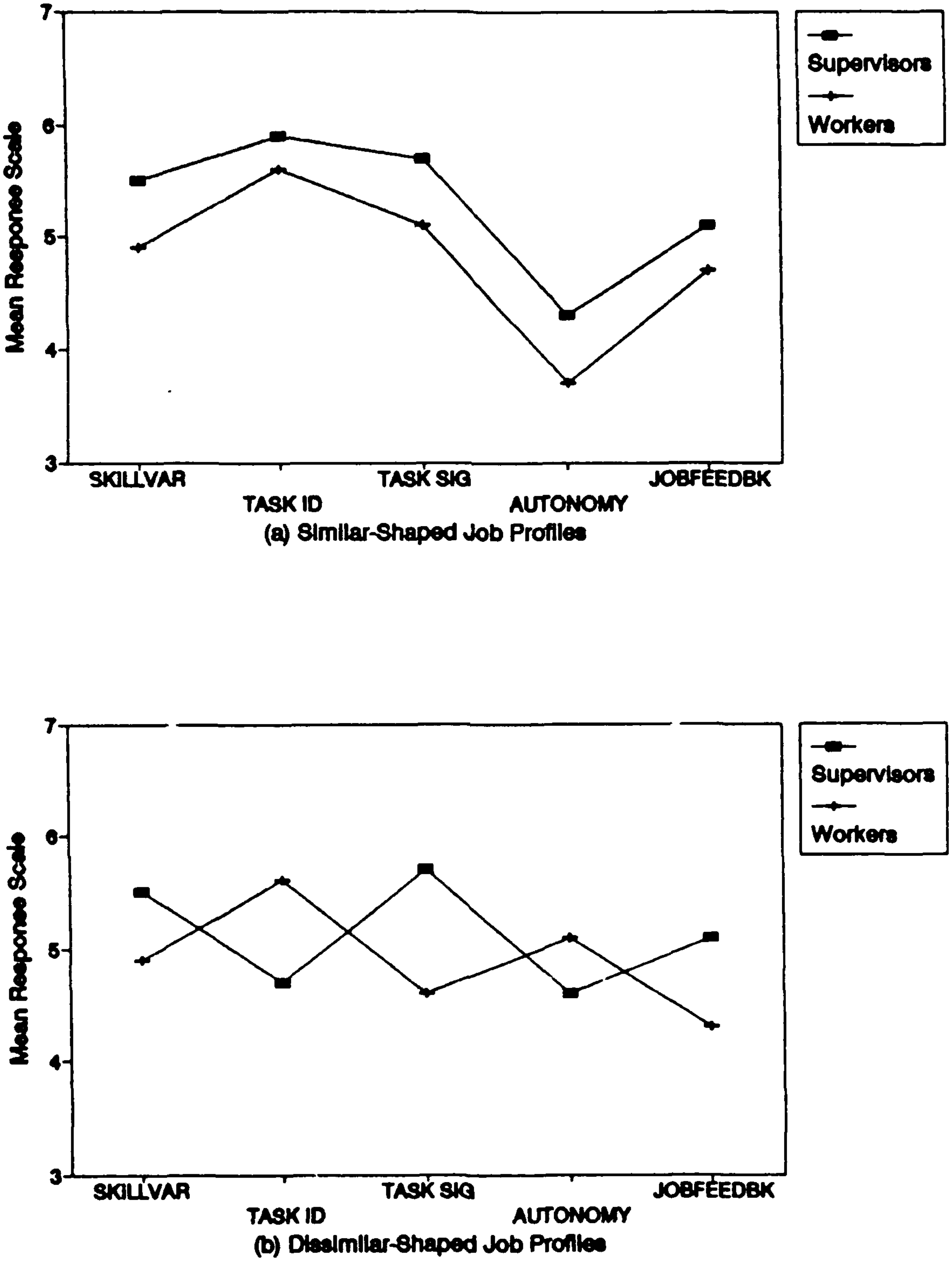


Figure 5. Comparisons of Similar and Dissimilar Job Dimension Profiles. (19:115)

MPS. Dunham used factor analysis on the JDS and found it best represented by a single-factor solution. Dunham proposed a four-factor compromise combining task variety and autonomy into a common factor in lieu of the "multi-dimensional construct of job characteristics" (10:409). A study by Fried and Ferris hypothesized that the dimensionality of the JDS "varies as a function of the personal and situational/contextual variables" (14:424). Fried and Ferris proposed combining skill variety, task significance, and autonomy into a single dimension when using the JCM for older, less formally educated, non-management workers.

Roberts and Glick also pointed out the lack of consideration for the "low GNS" worker within the JCM (38:201). This limitation of the model was also noted by Oldham and others:

> When individuals are not satisfied with the job context factors (pay, job security, co-workers or supervisors) their ability to respond positively to a job high in objective motivating potential may be severely diminished. (35:396)

These "low GNS" workers are more likely to use excess energy coping with the context problems instead of appreciating the inherent "richness" of the work (35:396).

Despite the many limitations cited against the JCM, the JDS has been widely used along with the JDI and the Job Characteristics Inventory (40:210). The use of the JRF is one advantage the JCM has over other models. Oldham points out that with the JRF supervisors can "provide an indirect

test of the objectivity of the employee descriptions of the characteristics of their own jobs" (35:397).

Birnbaum reported using the JRF, along with the JDS and the JDI, in a study of various jobs in Hong Kong (3). Birnbaum's conclusions indicated that supervisors can better distinguish the characteristics of the job than the workers. Although previous research relied primarily on job incumbents for evaluation, outside job analysts or supervisors could play a more prominent part in assessing job variety. Birnbaum hypothesized, "the supervisors were more emotionally removed from the jobs in question and had greater opportunity to observe different jobs in action" (3:603).

Models of Facet Satisfaction. In the same manner as Hackman and Oldham proposed the JCM as a revision to the Turner and Lawrence model, Lawler has continued to expand the portion of the Porter and Lawler model that deals with equity theory. Lawler's model deals with the perceptions workers have of their personal inputs and those of referent others in relation to the perceived outcomes or rewards received (26:385). Lawler theorizes that the overall job satisfaction of a worker is a combination of his or her satisfaction with the different aspects, or facets of the job, such as pay, supervisors, or the work itself.

Previous AFIT research by Daspit in 1978, Dixon, and Talbot in 1979 attempted to modify Lawler's model of job

facet satisfaction for specific applications to the career fields of U.S. Air Force personnel (5;8;45).

Model of Command Potential

In a similar approach to that taken by Dixon, Daspit, and Talbot's earlier studies, but not related to the facets of job satisfaction, this study developed a model to assist in evaluating the pilots' perceptions of mission command potential for navigators.

The intent of the questions added in the third section of the survey questionnaire was to develop a paradigm that could be used to ascertain more than an answer to the simple question, "What is the navigator's command potential?" Questions of command authority usually invoke differing opinions, regardless of the career field surveyed. The question of transferring mission command responsibility to the navigator would be difficult for any Air Force pilot to answer objectively, especially if the pilot had flown only single-seat fighters. Therefore, the questions in section three of the survey instrument attempted to develop an additional construct, arbitrarily referred to as command potential score (CPS), to assist in evaluating this issue.

To develop a model of command potential that could have possible correlations with the JRF, three attributes were proposed. First, the basic question of whether the navigator was needed in Air Force aircraft was investigated. Second, the value the navigator might provide toward mission

accomplishment or flight safety was evaluated. And third, the possibility that the navigator's experience might be more valuable for successful mission accomplishment than that of the pilots was addressed. It must be emphasized that no attempt was made to infer that the job satisfaction measurements of the JCM were in any way related to the mission command potential of this CPS model.

The proposed attributes, labeled Retain, Value, and Mission, were each defined as the mean score of three qualitatively-selected questions in the third section of the questionnaire. The methodology of the CPS computation and a description of the specific questions used to measure the CPS attributes are discussed in Chapter III.

Summary

This chapter has provided a review of three background issues which were essential in the development of this study. First, definitions of some of the important terms used in this research were provided. Second, a detailed review of appropriate portions of the literature was discussed. Special emphasis was placed on the motivation process theories of equity and expectancy. A review of the numerous job characteristics models prefaced the third issue which was a discussion of the models used specifically in this research. The methodology of analysis for this study is discussed in Chapter III.

III. Methodology

This chapter describes the research methodology used for this study. The survey instrument, sampling plan, and statistical tests used in this analysis are explained. A diagnostic plan highlights the steps taken in the data analysis. Limitations of the survey instrument are discussed along with assumptions pertinent to the data analysis. The chapter also describes the pretest and the pretest population of the survey questionnaire which was accomplished for this study.

Survey Instrument

A survey questionnaire was deemed appropriate for this research primarily because it was the most cost-effective method of obtaining the data. The opinion and attitude type of data required for this research could be obtained only through the use of a questionnaire (11:158).

In order to compare pilot and navigator perceptions of navigator job characteristics, it was considered essential to use a survey instrument similar to that used by Urban (50:31). The description of the Job Rating Form (JRF) in Chapter II has shown that it was designed to supplement the Job Diagnostic Survey (JDS) used by Urban, and Dotson and Hilbun. Therefore, the JRF was chosen as the primary survey instrument used for this study.

In addition to the JRF, ten questions were added in the Biographical Data section at the beginning of the questionnaire which obtained demographic information, flying experience, and supervisory experience of the respondents.

Nine additional questions were added in the third section of the questionnaire which addressed more specific issues concerning navigator job characteristics and were designed to gather data for evaluating the third research objective discussed in Chapter I. The questionnaire concluded with a statement encouraging the addition of any comments the respondent may have wished to add in the space provided on the last page. The survey instrument is contained in Appendix A.

As a partial review of the information provided in Chapter II, the JRF is designed to be administered to supervisors and outside observers of the job under consideration. The JRF measures the following five core job dimensions of the Job Characteristics Model (JCM):

1. <u>Skill Variety</u>
2. <u>Task Identity</u>
3. <u>Task Significance</u>
4. <u>Autonomy</u>
5. <u>Feedback from the Job Itself</u>

These five core job dimensions are used in computing the Motivating Potential Score (MPS):

$$\text{MPS} = \frac{\text{Skill variety} + \text{Task identity} + \text{Task significance}}{3} \times \text{Autonomy} \times \text{Job feedback}$$

The MPS formula demonstrates the greater impact that autonomy and job feedback have on internal job motivation than any of the other three core job dimensions. As explained in the previous chapter, autonomy and job feedback represent the JCM critical psychological states of "experienced responsibility" and "knowledge of results." According to Hackman and Oldham, these two critical states must be present in the job if internal job motivation is to be high (19:80). The multiplicative effects of autonomy and job feedback in the MPS formula support the model; low values of either would significantly lower the MPS and high values in both autonomy and job feedback are necessary for a high MPS. The third critical state of "experienced meaningfulness" is represented by skill variety, task identity, and task significance. The additive factor of these three job dimensions in the MPS formula reflects the lesser significance that a low score in one or two of these measures has for the overall MPS value (19:81).

Two additional dimensions, not addressed in the JCM, are measured by the JRF:

> Feedback from Agents. The degree to which the employee receives clear information about his of her performance from supervisors of from co-workers.
>
> Dealing with Others. The degree to which the job requires the employee to work closely with other people in carrying out the work activities (including dealings with other organization members and with external organizational "clients"). (18:5)

Because the JRF measures only the seven job dimensions and MPS of the JCM, only the means of these navigator job

characteristics from Urban's research are compared with the pilot responses of this study.

Limitations of the JRF. Hackman and Oldham point out the JDS and JRF instruments have certain limitations and caution against using the data without checking them with other independent data results. The first limitation given is the lack of independence of the job characteristics. Positive intercorrelations between the variables may indicate problems in the way the job characteristics are measured or they may only verify the idea that "good" jobs are good in more than one way and "bad" jobs, being poorly designed, have lower scores in many job characteristics (19:313).

Another limitation of the instrument is that the results of the instruments can be easily misrepresented. As in any self-response questionnaire, respondents need to be cautioned that their answers must "accurately reflect the objective characteristics of the jobs and their personal reactions to them" (19:314). The cover letter of the survey questionnaire sought to impress the importance for objective responses upon the respondents.

In addition, the instruments are not designed to be used for a single response. Not only is anonymity compromised in this situation, but internal consistency reliability may be sacrificed when less than five individuals are averaged for a given job (18:37).

The final limitation addressed the lack of validity in the instrument scales. Hackman and Oldham recognized that method variance was a potential problem. With the exception of the context satisfactions and growth need strength, method variance is reduced because "each variable is addressed in two different sections of the questionnaire, by items written in two different formats" (18:7). The Job Descriptive Index, a more proven measure of job satisfaction, was recommended when "highly trustworthy" measures were needed (19:314).

As discussed in Chapter II, the JRF data provide only a portion of the information that must be obtained for a "multiple-method" analysis for potential job redesign. Hackman and Oldham point out that data gained from workers seeking a change in job design should be supplemented by observations from "others not personally invested in the work unit" (19:102). Each methodology used in the assessment of job satisfaction has unique problems associated with it. Therefore, results gained from questionnaires should be reinforced with interviews and personal observations before job redesign is attempted (19:102).

Diagnostic Analysis Plan

The diagnostic steps taken in this study must follow the two-part problem statement discussed in Chapter I. The first portion of the diagnostic plan is a continuation of

the analysis performed by Urban in his 1989 research (50). The JRF data are to be used to supplement the data which Urban obtained with the JDS in his survey of Air Force navigators. As discussed in Chapter II, the job characteristics dimensions from the JDS and JRF analysis can be used to construct a profile of the job under consideration. As Hackman and Oldham suggested, these job profiles are important in evaluating a job for potential redesign; therefore, "it is not advisable to rely solely on employee-provided data in constructing them" (19:114). Hackman and Oldham point out five diagnostic steps to be used in any analysis for job redesign:

> 1. Are motivation and satisfaction really problematic? It is important to examine the scores of employees on motivation and satisfaction portions of the JDS as the first step in a job diagnosis.
>
> 2. Is the job low in motivation potential? Examine the Motivating Potential Score of the target job and compare it to the MPS scores of other jobs to determine whether or not the job itself is a probable cause of the motivational problems.
>
> 3. What specific aspects of the job are causing the difficulty? This step involves the examination of the job on each of the five Core Job Dimensions to pinpoint the specific strengths and weaknesses of the job as it currently exists. It is useful at this stage to construct a "profile" of the target job to make visually apparent where improvements need to be made.
>
> 4. How "ready" are the employees for change? An important factor is determining the growth need strength of the employees, since employees high on growth needs usually respond more readily to job enrichment than do employees with little need for growth.
>
> 5. What special problems and opportunities are present in the existing work system? Before undertaking actual job changes, attention should be given to any

> particular roadblocks which may exist in the organizational unit as it currently exists--and to any special opportunities which may be built upon in the change program. (18:34-35)

Urban's study analyzed the navigator career field using the five steps outlined by Hackman and Oldham. Other factors measured by the JDS, satisfaction with pay, job security, and supervision, help identify if job redesign can be easily accomplished. The first portion of the analysis plan for this study augments the results of Urban's research in the second and third steps of the JDS diagnostic plan. Given the JDS results of Urban's survey of navigators, the analysis of the pilot's JRF data is performed to measure if the differences in the means of the MPS and job satisfaction dimensions are significant.

The difficulty encountered in step five of the above plan, when attempting to redesign any military career field, is the basis for the second portion of the analysis plan for this study. Based on the results from Urban's study, all navigators experienced satisfaction problems in the areas of autonomy, growth satisfaction, job security, and pay satisfaction. Using the JDS diagnostic plan, Urban recommended job redesign for the navigators who perform the tanker and strategic airlift mission (50:100). However, because of the necessary restrictions and regulations imposed on military aircrew members, Urban recognized that opportunities for navigator job redesign are limited.

The second portion of this study's analysis plan is to evaluate the potential for senior, more experienced navigators to assume the mission commander responsibility instead of the aircraft commander. A model for evaluating the pilot's perception of the navigator's command potential was introduced in Chapter II which provided the diagnostic tool for this portion of the analysis plan. Comparisons of means, analysis of variance, and Pearson correlation tests were performed on the model variables in an attempt to identify significant associations with the job satisfaction characteristics of the JCM.

<u>Command Potential Score (CPS)</u>. The nine additional questions added in Section Three of the questionnaire were designed to ascertain the respondents' perception of the mission command potential of navigators. The CPS is an arbitrary measure designed to consolidate the responses to the Section Three questions. The CPS is computed as the product of three attributes:

Command Potential Score (CPS) = Retain X Value X Mission

The values of the proposed attributes, Retain, Value, and Mission, are each calculated as the mean score of three qualitatively-selected questions in the third section of the questionnaire. These questions are answered in the same manner as those in Section Two of the JRF using a seven-point scale which measures from a low of one (very

inaccurate) to a high of seven (very accurate). Therefore, the values of each attribute are scored in the same manner as the values of the job dimensions of the JCM. Using this method of scoring the command potential attributes, the possible values of the CPS (1 to 343) are the same as those for the MPS. The scoring key for the questionnaire is contained in Appendix C.

CPS Comparison with the MPS. No attempt was made *a priori* to infer that the job satisfaction measurements of the JCM are in any way related to the navigator command potential of this CPS model. The benefit of calculating the CPS in this manner is simply for direct comparison with the MPS when possible associations between the two scores are investigated. The discussion of JCM criticism in Chapter II revealed that the method of calculating the MPS was also under debate. Rather than compare all nine of the Section Three questions separately, the CPS attempts to place command potential into a single scale in a manner similar to the MPS measurement of internal work motivation (19:81).

As Hackman and Oldham explained a "high" MPS value does not "*cause* employees who work on that job to be internally motivated, to perform well, or to experience job satisfaction" (19:82). The MPS merely reflects the degree to which a worker *may* receive "enrichment" from the job should the worker desire to take advantage of the opportunity. In the same manner, a high CPS value is

designed to reflect the degree of command potential that the job provides the worker. The worker's behavior in that job determines whether command opportunities will be considered.

The MPS values from this study can be compared to the navigator MPS values from Urban's study and the normative data for professional workers. Pilot assessments of the need for navigator job redesign are made based on the comparisons of the MPS values. Low MPS values would indicate that the core job dimensions do not provide enough internal work motivation for the navigator and job redesign may be required. By intentionally designing the CPS to be compatible with the MPS, associations between the two values may be made which could predict the pilots' perception of the navigators' command potential based on the perception of the work motivating potential of the career field.

Command Potential Attributes. After a qualitative assessment of the questions from the third section of the questionnaire, the three attributes were operationally defined and matched with Section Three questions:

Retain. The respondent's attitude toward the overall need for the navigator in U.S. Air Force aircraft.

1. The increasing complexity of operating advanced weapon systems, such as the F-15E, indicates the need to retain the expertise of the navigator/WSO in advanced fighter aircraft.

2. The Global Positioning Satellite (GPS) system and improved inertial navigation systems have replaced the requirement for the navigator/WSO in military aircraft.

7. The navigator/WSO crew position should have been included on recently developed aircraft, such as the C-17 and B-2.

Value. The respondents's attitude concerning the value of the navigator in Air Force aircraft for mission accomplishment and/or flight safety.

3. Pilots can become task-saturated by the many activities associated with take-off, departure, and approach to landing, low-level flight, and inflight emergencies. The additional set of eyes and ears of the navigator/WSO is critical to mission success and flight safety.

6. The expertise of the navigator/WSO is needed only on designated missions, such as airdrop and low-level, where the normal positioning errors of inertial navigational equipment could critically affect mission success or flight safety.

9. On multi-place aircraft, the senior rated officer (assuming equal or greater flight experience) should be designated as mission commander, even if it is the navigator/WSO, as long as his or her duties do not conflict with those of the aircraft commander.

Mission. The respondent's attitude concerning if and when the navigator's experience might be more valuable for successful mission accomplishment than the pilots.

4. Although the aircraft commander is ultimately responsible for "safety of flight" decisions, he or she often relies on the navigator/WSO, if available, for assistance in making mission-related decisions.

5. An experienced navigator/WSO is better qualified to make mission-related decisions than a less-experienced pilot.

8. An experienced navigator/WSO who makes mission-related decisions will better enable the pilot to make correct decisions concerning flight safety issues.

The lack of independence of the three attributes is obvious. The Section Three questions were not designed to measure three independent attributes for command potential. The attributes were an afterthought intended to define different aspects of the navigator mission command issue. Some of the questions may be used interchangeably to define any of the three attributes; different variations were evaluated before the above designations were chosen. Because the attributes are "weighted" the same in the CPS formula, changing the questions which define the attributes does not significantly change the quantitative values of the CPS. It must be emphasized that the main purpose for the CPS measure is to gain a unidimensional value comparable to the MPS. If higher CPS values can be associated with higher

values of the MPS, predictive associations may be made to determine if certain aircraft missions provide more command potential for the navigator than others. Individual comparisons of the Section Three questions are made in Chapter IV when this type of analysis is judged to be significant. The reliability and validity of the command potential measurements are also discussed in Chapter IV.

Survey Population and Sampling Plan

The target population for this research consisted of all active duty U.S. Air Force pilots with the rank of first lieutenant through major, currently assigned to flying status. The external validity of the survey could have been hindered by surveying only those pilots flying aircraft which require a navigator as part of the crew composition. Pilots now flying aircraft that do not require a navigator may have flown with navigators in previous assignments. According to Mitchell, by not limiting the population to pilots currently flying aircraft with navigators, external validity is strengthened in the attempt "to generalize a particular finding across different measures, settings, and populations" (32:198).

Pilots in staff positions were not considered in the population because their current non-flying, primary duties might not permit actual observation of navigator inflight duties. Therefore, only pilots possessing 10XX, 11XX, 12XX, and 286X (test pilots) Air Force Specialty Codes were

considered for the survey population. As done in Urban's study, the rank structure was selected to exclude those whose limited experience might hinder their knowledge of navigator job responsibilities (second lieutenants) and those whose flying duties might be limited (lieutenant colonels and above) because of command responsibilities (50:39).

A random sampling plan used in conjunction with the ATLAS database of the Air Force Military Personnel Center (HQ AFMPC) further supported the external validity of the research. A sample, stratified proportionally by rank, was initially proposed, but this plan was abandoned when the first attempt to obtain mailing labels for the survey did not include all the required Air Force Specialty Codes.

One limitation to the sampling plan was the current restriction on sample size for all Air Force academic research. The approval authority has limited the sample size to that which will provide only a 90 $\pm$10 percent level of confidence that the sample mean approximates the mean of the population. The preferred level of confidence is 95 $\pm$5 percent for this type of research. The lower confidence level reduces the total number of survey questionnaires circulated, lowers the overall costs of the research, and because of the homogeneity of the population, does not significantly affect the external validity of the results (11:287-295).

However, stratifying the population by rank, or by type of aircraft and mission flown as was done by Urban, does have implications for the justification of a larger sample size. This additional limitation to the sampling plan will be addressed in Chapter IV.

Statistical Analysis

The three objectives for this research, discussed in Chapter I, were evaluated by analyzing the survey responses to the three investigative questions. The first research objective was evaluated by the first investigative question:

1. As indicated by the JRF, how do U.S. Air Force pilots perceive navigator motivation and job satisfaction characteristics compared to the JDS responses of U.S. Air Force navigators and the normative data for professional workers?

The second research objective was designed to analyze any significance associated with the military experience (indicated by rank) and navigator supervisory experience of the respondent in order to identify possible differences in pilot perceptions of navigator job satisfaction. The second investigative question evaluated this objective:

2. How does the pilot's overall military experience, determined by rank, and supervisory experience with navigators relate to whether a need for navigator job redesign is indicated in the results of the JRF data?

The final research objective attempted to ascertain the pilot's perception of how well the navigator could perform as a mission commander. This third objective was evaluated with the remaining investigative question:

3. What is the pilot's perception of the value and continued requirement for the navigator career field? How does this value perception compare to the pilot's attitude toward surrendering mission commander responsibility to a more experienced, senior navigator?

Statistical Tests. Various statistical tests were available to analyze the degree of association exhibited by the correlational data obtained from this research. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS-X) available through the AFIT Computer Services Division (AFIT/SC) and two personal computer software programs, Statistix II and MathCAD.

Comparison of means, analysis of variance, and correlational analysis were chosen as the preferred statistical tests to use in analyzing the survey data. A description of the procedures used in the statistical tests is contained in Appendix D.

Pretest of the Survey Instrument

Efforts to strengthen the stability and content validity of the additional questions added to the questionnaire dictated that a pretest of the entire survey

instrument be accomplished. Emory points out that the "importance of the test-revise-retest cycle cannot be overstressed. The failure to take this important step is one of the greatest causes of poor sampling results" (11:207).

Before a pretest was conducted, the questionnaire was administered to five pilots enrolled in graduate programs at AFIT's Schools of Engineering and Systems and Logistics. After minor changes were made to the Section Three questions, the actual pretest was accomplished at the 4950th Test Wing at Wright-Patterson AFB, Ohio. The 4950th was chosen primarily for convenience but the author's familiarity with the organization and its mission was also a consideration.

One benefit in using the 4950th pertained to the conclusions drawn in Urban's thesis. The 4950th, one of only three test wings in Air Force Systems Command (AFSC), is the only test wing which operates multi-place (C-135 and C-141) aircraft. All aircrew members of the 4950th must have prior flying experience in an operational flying command, such as SAC or the Military Airlift Command (MAC), before being assigned to AFSC. Most of the aircrew members, with the exception of two test pilots, gained their experience flying either tanker or strategic airlift missions. As previously discussed, tanker and strategic airlift navigators, according to Urban, are the most in need of job redesign (50:100). Obtaining initial inputs from

pilots with this type of flying background was considered an additional advantage in performing the pretest.

Coincidentally, a drawback in using the 4950th for a pretest was also the previous experience of the pilots. There were no first lieutenant pilots assigned to the test wing and all but two of the respondents had some navigator supervisory experience. Because the main purpose for the pretest was to obtain inputs on the nine questions added to the survey instrument, the more senior pilot sample was not considered a strong bias to the results.

The pretest was distributed to all sixty pilots in the rank of captain through lieutenant colonel in the 4950th with 38 (63.3 percent) being returned. Eight of the pretest questionnaires were completed by pilots in staff positions and, for this reason, only thirty were analyzed. The pretest respondents consisted of ten majors and 20 captains. Eight flew the C-141 aircraft and 22 flew the C/EC-135 aircraft. Four of the respondents were in the 36 to 40 age range, 12 were in the 31 to 35 year group, and 15 were less than 30 years old. The average total flying hours for the pretest respondents was 2508.6. Over 70 percent of the respondents had more than 2000 hours total flight time. Three of the respondents were female.

Table 1 presents the comparison between Hackman and Oldham's normative data for professional workers, the sample means and standard deviations for the MPS and job dimensions

TABLE 1

COMPARISON OF MEANS OF PRETEST RESPONSES

	SV	TI	TS	AU	FJ	FA	DO	MPS
NORMS*								
means =	5.40	5.10	5.60	5.40	5.10	4.20	5.80	154.0
PRETEST (n=30)								
means =	4.81	5.01	5.45	4.23	5.54	4.90	5.96	121.5
std dev =	1.04	1.00	0.97	1.03	0.90	1.08	0.83	54.6
T value								
w/NORMS =	-3.11	-0.49	-0.85	-6.22	2.69	3.55	1.06	-3.26
P value =	.004	.628	.402	.000	.012	.001	.298	.003
df=29	***			***	***	***		***
NAVS** (n=74)								
means =	5.23	4.97	5.58	4.59	5.29	4.60	6.14	135.6
std dev =	1.12	1.18	1.27	1.23	1.03	1.42	0.83	61.3
T value								
w/PRETEST =	1.77	-0.16	0.50	1.41	-1.16	-1.04	1.00	1.10
P value =	.080	.873	.618	.162	.249	.301	.320	.274
df=102								

LEGEND

SV = Skill Variety
TS = Task Significance
FJ = Feedback from the Job
DO = Dealing with Others
MPS = Motivating Potential Score
TI = Task Identity
AU = Autonomy
FA = Feedback from Agents
df = degrees of freedom
std dev = standard deviation

* Normative data based on the responses of 6930 workers in 52 different career fields (19:313).

** Navigator means and standard deviations based on the responses of 74 U.S. Air Force navigators (50:53).

*** These differences in means significant at an alpha value equal to .05 for a two-tailed test.

of the pretest pilots, and Urban's navigator responses. T values and P values are indicated between each comparison category. As the t-tests results of Table 1 indicate, the pretest pilot responses for navigator Skill Variety, Autonomy, and MPS are significantly below the norms established by Hackman and Oldham. Urban reported that the navigator mean for Autonomy was also significantly below the professional norm (at a .10 alpha value); however, the means for Skill Variety and the MPS were statistically the same as the means of the normative data (50:56).

Both the pretest pilots and Urban's navigators responded with higher means for Job Feedback, Feedback from Agents, and Dealing with Others than those of the normative data. The pilots' means for both types of feedback (job and agents) were significantly higher than the norm. Means for feedback from agents and dealing with others were significantly higher (at a .10 alpha) for the navigator responses (50:56).

Higher values of these job dimensions are expected and, as Urban pointed out, both types of feedback and dealing with others are common occurrences in the navigator's job experience (50:60-61). All crewmembers must "deal with others" and coordinate their actions if the mission is to be accomplished effectively. Navigators usually receive some type of feedback, either from their job performance or other crewmembers, each time they fly. Although, as Table 1 indicates, the pilots' and navigators' means were

statistically equal for all the variables at a .05 alpha, the pilots' means were lower than those of the navigators in four of the seven variables.

The primary purpose of the pretest was to improve the reliability and validity of the third section of the questionnaire. As a result of comments received from the pretest respondents, numerous changes were made to the wording of some of the questions in section three.

Further changes and a rearrangement of the Section Three questions were made after the survey instrument was reviewed by faculty members in AFIT's Communications and Organizational Sciences Department (AFIT/LSR). The pretest questions for section three are contained in Appendix B for comparison with those used in the actual survey instrument.

Summary

This chapter has presented the data analysis plan used for this study. The survey instrument, sampling plan, and their applicable limitations were discussed. The steps taken in the analysis of each investigative question were presented. Finally, the pretest population and analysis of the pretest results were described. The analysis and findings of the survey response data and the evaluation of the research objectives for this study are presented in Chapter IV.

IV. Data Analysis

The purpose of this chapter is to present the results of the analysis plan outlined in the methodology of Chapter III. All data used in this analysis were obtained either from the pilot responses to the survey questionnaire or from Urban's previous research on navigator job satisfaction (50). The response rates of the questionnaires and demographic data of the respondents are presented. An analysis of each of the investigative questions is reported as a means to evaluate the research objectives of this study. Applicable qualitative comments from the returned questionnaires are provided throughout the chapter to add emphasis or credibility to the quantitative analyses.

Analysis of the Sample

As discussed in Chapter III, the sample size for this research survey was dictated by the limitations imposed by the approval authority at HQ AFMPC. Surveys conducted within the Air Force for academic research are limited to a 90 $\pm$10 percent confidence level. For a population size of 10,914 pilots, provided by the ATLAS database, HQ AFMPC approved a sample size of 67 with 100 percent oversampling to allow for non-responses. Therefore, 134 survey questionnaires were originally mailed. The AFMPC ATLAS database was used initially to randomly select a stratified

sample according to rank. The intention was to survey a representative sample of all active duty Air Force pilots in the ranks of first lieutenant, captain, and major.

After the questionnaires were mailed, it was discovered that the ATLAS inquiry had failed to sample from all pilot Air Force Specialty Codes. The fighter and bomber pilots had not been included. To minimize the impact of oversampling and still maintain a legitimate sample of all Air Force pilots, a second ATLAS inquiry was made to obtain 134 names selected by a simple random sample (no stratification by rank). Only fighter and bomber pilots were used from this second sample list to prevent excessive oversampling of the pilots from other aircraft. As a result of the second inquiry, 69 additional questionnaires were mailed to the fighter and bomber pilots approximately one month after the first mailing. A total of 203 questionnaires were mailed and 114 were returned, for an overall response rate of 56.2 percent.

The aircraft categories for this study are defined as:

Fighter/Trainer/Helicopter. All single and two-seat fighter and attack aircraft, training aircraft (T-37, T-38, and T-43), and helicopters.

Tankers. C/EC/KC-135 and KC-10 aircraft.

Strategic Airlift. C-5, C-9, C-12, C-20, C-21, and C-141 aircraft.

Tactical Airlift/Rescue. C-23 and C/HC-130 aircraft.

Strategic Bomber. B-1, and B-52 aircraft.

Table 2 indicates the number of responses received by rank and aircraft compared to the number of questionnaires that were mailed in each category. The fighter/trainer/helicopter aircraft were combined into one category because of the difficulty in determining *a priori* which type of aircraft the pilots actually flew. The address labels

TABLE 2

SURVEY RESPONSE RATES BY RANK AND AIRCRAFT

RANK / AIRCRAFT	1LT	CAPT	MAJ	TOTAL RETRND	TOTAL MAILED	PERCENT RETURNED
Ftr/Trnr/Helo	2	14	9	28	53	51.9%
Tanker	10	21	5	36	64	56.3%
Strat Airlift	1	13	8	24	36	66.7%
Tac Alft/Rescue	5	6	4	12	30	40.0%
Strat Bomber	4	9	3	14	20	70.0%
TOTAL RETURNED	22	63	29	114		
TOTAL MAILED	43	120	40		203	
PERCENT RETRND	51.2%	52.5%	72.5%			56.2%

furnished by the ATLAS database did not include Air Force Specialty Codes, only the name of the individual and organization address were provided. Therefore, it was impossible to determine the response rates of certain aircraft categories, such as two-seat compared to single-seat fighters.

Table 3 indicates the number of survey responses received, as reported in Table 2, that could actually be used. The data in Table 3 reflects significantly lower usage rates among the fighter/trainer/helicopter and strategic airlift categories.

A total of 21 questionnaires that were returned could not be used for the survey analysis. One questionnaire not used was answered by a lieutenant colonel in a staff position who was not on active flying status. Four of those returned were not entirely completed: two were returned by KC-10 copilots who noted they had never flown with a navigator, one was from an AT-38 pilot who answered only the third section, and the fourth was from an F-15 pilot who filled out the biographical data only and added the comments, "I have no idea. I fly a single seat F-15C. WSO! What's a WSO?"

As discussed in Chapters I and III, no attempt was made to limit the survey sample to only those pilots currently flying with navigators. Many pilots now flying single-seat fighters have previous experience in two-seat aircraft, such as the F-4 or F/FB-111 fighters. The sixth question in the biographical data section attempted to identify those pilots who had previous experience in navigator-required aircraft.

Unfortunately, sixteen of the responses were from pilots with no experience as co-workers or supervisors of navigators and, even though they filled out the questionnaires, their responses were not used. The data

TABLE 3

USABLE SURVEY RESPONSES BY RANK AND AIRCRAFT

RANK	1LT	CAPT	MAJ	TOTAL USED	TOTAL MAILED	PERCENT USED
AIRCRAFT						
Ftr/Trnr/Helo	0	5	5	10	53	18.9%
Tanker	8	21	5	34	64	53.1%
Strat Airlift	1	11	6	18	36	50.0%
Tac Alft/Rescue	5	6	4	15	30	50.0%
Strat Bomber	4	9	3	16	20	80.0%
TOTAL USED	18	52	23	93		
TOTAL MAILED	43	120	40		203	
PERCENT USED	41.9%	43.3%	57.5%			45.8%

from these sixteen questionnaires, completed by pilots having no flight experience with navigators, are examples of one of the survey limitations addressed in Chapter I. The respondents tried to be helpful by answering the questions as best they could but did not have actual knowledge of the job under consideration.

Several comments from these sixteen unused surveys explained the lack of validity associated with the responses. None of the three helicopter pilot's responses which were returned could be used. A MH-60 helicopter instructor pilot with 2100 total flying hours commented, "I'm a helo pilot, what do I know about navigators"?

Another helicopter pilot, a special missions UH-1 pilot with 2400 flying hours, gave this comment:

> Because my aircraft does not have, need, or want a navigator, my answers here are based on what my perceptions are from my "big MAC" buddies. I know that I do all the safety of flight and low level and TOT's, course adjustments, reading the map, and all on goggles without a navigator, give me a GPS any day, eats less, doesn't need crew rest, will not complain.

An A-10 pilot with 2400 flying hours responded with comments that included, "From all the F-4 jocks I have talked to, a good WSO is a great asset, especially during a hi-bogey environment." Another A-10 pilot responded with a comment that illustrated the validity of his responses, "Asking an A-10 pilot about WSO's is a waste of time and money."

The tactical airlift and strategic bomber categories in Table 3 gained in "percent used" compared to "percent returned." This apparent growth is because several of the fighter, KC-10, C-5, and trainer pilots had previous experience in navigator-required aircraft. A T-38 instructor pilot had previous B-52 bomber experience. One KC-10 pilot also had B-52 experience and another had C-130 experience. All respondents with previous navigator-required aircraft experience, who were currently flying aircraft that did not require a navigator, were placed in the category of the previous aircraft for the survey analysis. Therefore, Table 3 reflects the net changes of the aircraft categories after the previous aircraft experience was taken into consideration.

Demographic Analysis

The FREQUENCIES and CROSSTABS subprograms of SPSS-X were used to build tables representing the frequency counts and cumulative frequency distributions of all variables contained in the response data. Of the 93 usable responses 52 captains (55.9 percent), 23 majors (24.7 percent), and 18 first lieutenants (19.4 percent) were analyzed. Based upon the current totals from the ATLAS database of 10,914 pilots actively flying in the Air Force Specialty Codes applicable to this study, 6,697 (61.4 percent) are captains, 2,251 (20.6 percent) are majors, and 1,966 (18 percent) are first lieutenants. Although the final sample was not completely stratified by rank, the usable responses did approximate the population proportion of majors, captains, and first lieutenants.

By aircraft, 10.8 percent of the usable responses were from fighter pilots (F/FB/EF-111, F-15E, and F-4), 36.6 percent from tankers (KC-135 and KC-10), 19.4 percent from strategic airlift (C-141 and C-5), 16.1 percent from tactical airlift and rescue (C/HC-130), and 17.2 percent from strategic bomber (B-1 and B-52).

The ages of the respondents are presented in Table 4, and the expected relationship between the age and military rank is readily apparent.

The average total flying hours for the survey respondents was 2059.6, approximately 500 hours less than

TABLE 4

AGES OF SURVEY RESPONDENTS ACCORDING TO RANK

RANK	1LT	CAPT	MAJ	TOTAL	PERCENTAGE OF TOTAL
AGE CATEGORY					
Under 26	7	0	0	7	7.5%
26 to 30	11	38	0	49	52.7%
31 to 35	0	13	6	19	20.4%
36 to 40	0	0	9	9	9.7%
Over 40	0	1	8	9	9.7%
TOTAL	18	52	23	93	
PERCENT OF TOTAL	19.4%	55.9%	24.7%		100.0%

those in the pretest sample discussed in Chapter III. However, 29 percent of the survey respondents had over 2500 hours of total flying time. Overall, 24 of the pilots had previous experience in navigator-required aircraft while four had previous experience as a navigator. Of the 93 usable respondents of the survey, 55 (59.1 percent) had experience as a navigator supervisor.

Only two females were sampled in the survey, and both returned the completed questionnaire. However, one female respondent was a C-5 pilot with no previous flying experience with navigators. Based on the predetermined criteria, only the responses from the other female, a KC-135 pilot, were used in the analysis.

The female C-5 pilot did provide a valuable comment that seems to exemplify another opinion of navigators than those quoted earlier:

> The navigator has a valid and important role on <u>some</u> aircraft . . . . I think the aircraft that have navigators on them now, do need them. I don't fly with any navigators now, but I do respect their job quite a bit. I still think the aircraft commander should always be the one in charge, no matter what the rank or experience. It's traditional and what people expect.

<u>Generalizability of Subcategory Data</u>. A caution is required concerning the size of the sample data used in the comparisons by rank and aircraft type subcategories. Assumptions about normality, variances, and even the generalizability of the sample data become suspect when the sample sizes become significantly lower than 30. As discussed in Appendix D, the t-test is robust for violations of these assumptions. Yet, a sample size of 10 or less is questionable for generalizability to the subpopulation that the sample represents.

Analyzing the survey responses by rank, or aircraft and type of mission, attempts to stratify the population by making inferences based on the differences in the means of the subcategories' respondents. However, a subcategory of 18 first lieutenant responses, for example, does not represent a 90 percent confidence level for the 1,966 first lieutenant pilots provided in the ATLAS database. This fact is illustrated in Appendix E with a MathCAD template of the HQ USAF/ACM formula used for computing sample sizes (6:11).

The variables of the formula are constant for each calculation given, except for N, the size of the population. The first equation demonstrates how a sample size of 67 was provided for this study based on a population of N = 10,914. To gain a 90 percent confidence level for a subpopulation of 1,966 first lieutenant pilots, the second equation yields a sample size requirement of 65. Just to obtain a similar confidence level for the pretest of 60 pilots, the third equation indicates a sample size of 32 is required.

The equation for sample size computation does not take the homogeneity of the population into consideration. The "d" or "tolerance factor" in the Appendix E formula represents the measure of dispersion (variance) in the population (11:295). However, the tolerance factor would have to be doubled to significantly lower the sample sizes required above. The tolerance factor should not be altered to make the sample size "fit" the data.

An assumption on the homogeneity of the sample size is a possible explanation for the acceptance of small samples. Many researchers agree that U.S. Air Force officers, pilots and navigators in particular, are similar in psychological characteristics. Qualification tests for undergraduate flight training are designed to account for these similarities. Emory points out that a sample size of <u>one</u> is acceptable when the population is known to be identical (11:287). Therefore, because the amount of variation is smaller in homogeneous populations, inferences from data

obtained from small sample sizes can be made with some credibility. However, qualitative analysis must be given some consideration when the sample sizes are reduced significantly due to stratification into subcategories.

Qualitative Analysis. As indicated by the comments of those pilots whose responses were not used, valuable qualitative information can be gained from these comments to supplement the quantitative analysis of the data. The limitations of the survey questionnaire and the sampling plan have been discussed, yet the value of the subjective comments which were included in 56 (60.2 percent) of the responses is difficult to estimate. Urban recognized the qualitative value of the comments of the navigators who responded to his survey (50:57).

A cross-section of representative pilot comments are provided throughout Chapters IV and V. A brief biographical sketch of the pilot accompanies each comment. The MPS and CPS values are included for quantitative comparisons. As discussed in Chapter III, relatively low MPS and CPS values may indicate that pilots' perceive the career field as offering low internal work motivation and command opportunity. The converse could be true for high values. The following comments represent the range of perceptions that were noted in the strategic airlift category:

A C-141 Aircraft Commander, captain, 26-30 years old with 1800 total hours and no navigator supervisory experience (MPS = 125.5, CPS = 192.1) said,

> I am a relatively new aircraft commander. However, on the numerous airdrop missions of which I've flown, I strongly feel the navs were indispensable. I feel that young AC's are not aware of how capable the navs are and what they can offer, thus limiting their impact on the mission.

A C-141 Instructor Aircraft Commander, major, 36-40 years old with 4800 total hours and supervisory experience (MPS = 47.5, CPS = 22.2) argued,

> Until we begin to all speak Russian and adopt the Soviet system of making the nav the AC, I don't think the nav can become the airborne mission commander. Operational flight experience is <u>not</u> and will never be the same as command experience, regardless of the amount of flight time or years of service. Someday soon, pilots will also become obsolete.

A C-141 First Pilot, first lieutenant, under 26 years old with 1000 total hours and no navigator supervisory experience (MPS = 125.3, CPS = 6.7) added,

> Navigators are not needed for the strategic airlift mission of the C-141. They are needed for navigation on special operations low level (SOLL) missions and are very valuable for the actual airdrop sequence during airdrops.

As expected, various opinions can be found among pilots concerning the navigator career field. However, in some cases, the MPS and CPS values may not be consistent with the perceptions reflected in the comments. Qualitative analyses may sometimes be more valuable than the quantitative measures. Appendix G contains additional selected comments that are not contained elsewhere in Chapters IV or V.

Analysis of Investigative Questions

As outlined in Chapter III, the analysis plan for this study is to quantitatively examine the data from the survey responses by addressing each of the investigative questions. The three research objectives of this study can then be evaluated based on the conclusions drawn from the results of the analysis. The first investigative question addressed the first objective:

1. As indicated by the JRF, how do U.S. Air Force pilots perceive navigator motivation and job satisfaction characteristics compared to the perceptions of U.S. Air Force navigators and the normative data for professional workers?

The comparison of means, described in Appendix D, was the primary statistical tool used for analyzing the first investigative question. The norms for professional workers provided by Hackman and Oldham were used as the population mean (μ) in each of the calculations performed using the first formula of the MathCAD template shown in Appendix F (19:313).

The sample means and standard deviations from Urban's research were substituted for 'xbar' and 's1,' respectively, in the MathCAD template while 'xbar2' and 's2' represented the same values for the pilots' responses for each category of the two-sample t-tests.

Table 5 presents a three-way comparison of means of the pilots' responses for MPS and job dimensions, the normative

data of the same variables for professional workers, and the sample means of Urban's survey results of 74 Air Force navigators. T values and P values are provided between each comparison category along with "***" to indicate significance at a .05 alpha value.

As presented in Table 5, the pilot responses for navigator skill variety, autonomy, and MPS are significantly below the norms established by Hackman and Oldham. Based on these results, the pilots' perception is that the navigator's job lacks the variety of tasks and control of outcomes that the normal professional worker would have. The lower MPS indicates that, as an aggregate measure for all pilots' perceptions, the job of the navigator does need to be redesigned.

The only variable significantly different between the pilots' responses and Urban's navigator responses, is in Feedback from Agents, where the pilots' mean is higher than that of the navigators. Intuitively, one would expect the Feedback from Agents mean to be higher for the pilots' responses, because pilots are usually the "agents" providing the feedback to the navigators. Most agents, regardless of the career field, would perceive that they provide more feedback to the worker on the job than the worker "perceives" receiving.

The pilot results in Table 5 also indicate significantly higher means in Feedback from the Job and Feedback from Agents than the norms for professional

TABLE 5

COMPARISON OF MPS AND JOB DIMENSION VARIABLES

	SV	TI	TS	AU	FJ	FA	DO	MPS
NORMS*								
means =	5.40	5.10	5.60	5.40	5.10	4.20	5.80	154.0
PILOTS (n=93)								
means =	4.98	4.90	5.69	4.38	5.54	5.07	5.90	130.8
std dev =	1.04	1.00	0.97	1.03	0.90	1.08	0.83	54.6
T value w/NORMS =	-3.89	-1.93	0.89	-9.55	4.72	7.77	1.16	-4.10
P value =	.000	.057	.376	.000	.000	.000	.249	.000
df=92	***			***	***	***		***
NAVS** (n=74)								
means =	5.23	4.97	5.58	4.59	5.29	4.60	6.14	135.6
std dev =	1.12	1.18	1.27	1.23	1.03	1.42	0.83	61.3
T value w/PILOTS =	1.49	0.42	-0.64	1.20	-1.67	-2.43	1.86	0.53
P value =	.138	.675	.523	.232	.097	.016	.065	.597
df=165						***		

LEGEND

SV = Skill Variety
TS = Task Significance
FJ = Feedback from the Job
DO = Dealing with Others
MPS = Motivating Potential Score
TI = Task Identity
AU = Autonomy
FA = Feedback from Agents
df = degrees of freedom
std dev = standard deviation

* Normative data based on the responses of 6930 workers in 52 different career fields (19:313).

** Navigator means and standard deviations based on the responses of 74 U.S. Air Force navigators (50:53).

*** These differences in means significant at an alpha value equal to .05 for a two-tailed test.

workers. These higher responses for feedback are to be expected. Various forms of feedback are provided in the military career fields, especially those of aircrew members, which are not found in the civilian workplace. The navigator receives feedback on job performance on each flight and regular feedback from agents from performance reports and annual flight qualification evaluations.

Analysis by Type of Aircraft. One objective of Urban's research was to test the hypothesis that navigator job satisfaction was dependent on the type of aircraft or mission that the navigator flew. From his analysis of navigator responses, Urban concluded that only navigators flying the tanker and strategic airlift missions were in need of a job redesign (50:100). Before analyzing the data by mission, Urban first divided the aircraft into two categories:

> Multi-place. An aircraft normally having more than two crewmembers and more than two engines; often referred to as a "heavy" aircraft (Examples: B-1, B-52, C-130, KC-135, C-141).
>
> Fighter-type. An aircraft normally having one or two crewmembers and no more than two engines (Examples: F-4, F/FB-111, F-15E, SR-71). (50:64)

Using Urban's aircraft type categories for the pilot responses in this study, a comparison of means can be made with the similar aircraft type navigator responses from his research. Once again, the MathCAD and Statistix II software were used in this analysis. Urban did not report the standard deviations for the sample means of the variables in

his analysis by aircraft and mission type (50:69,80). Therefore, the sample standard deviations from the pilots' sample means for each sample variable were used for the sample standard deviation of both sample means in the MathCAD formula (s1 and s2 in the two sample T-test formula presented in Appendix F). As reported by Kachigan, slight variations in the sample variability should not have a significant impact on the T values or P values in this computation (24:461).

The analysis of the means for the navigator job dimensions and MPS according to type of aircraft is presented in Table 6. Rather than begin with the one sample t-test comparison of the pilot means with the professional norms as was presented in the Table 5, the navigator and pilot two-sample comparisons of the job dimensions and MPS for fighter-type and multi-place aircraft are presented.

The first portion of Table 6 indicates that although all of the fighter-type pilots' means are less than those of the navigators, none of the differences is significant. The second portion of Table 6 indicates that the multi-place pilots responded significantly higher than the navigators in four of the seven job dimensions. The MPS for the multi-place pilots was higher also but not significantly.

The sample size of ten for pilot responses in the fighter-type category must be taken into consideration. As previously stated, generalizability is questionable for all

TABLE 6

COMPARISON OF MEANS BY TYPE OF AIRCRAFT

	SV	TI	TS	AU	FJ	FA	DO	MPS
				FIGHTER-TYPE				
NAVS*/** (n=30)								
means =	5.64	4.65	6.01	4.66	5.32	4.78	6.03	140.9
PILOTS (n=10)								
means =	5.23	4.03	5.33	4.30	4.93	4.66	5.70	112.6
std dev =	1.39	0.94	0.98	1.01	1.23	1.07	1.48	54.4
T value w/NAVS =	0.81	1.81	1.90	0.98	0.87	0.31	0.61	1.43
P value =	.423	.078	.065	.333	.390	.758	.545	.161
df=38								
				MULTI-PLACE				
NAVS*/** (n=44)								
means =	4.95	5.19	5.29	4.54	5.28	4.48	6.22	131.9
PILOTS (n=83)								
means =	4.95	5.00	5.71	4.39	5.61	5.12	5.92	133.0
std dev =	0.99	0.96	0.97	1.04	0.84	1.08	0.73	54.5
T value w/NAVS =	0.00	1.06	-2.32	0.77	-2.11	-3.18	2.20	-0.11
P value =	1.00	.291	.022	.443	.037	.002	.030	.913
df=125			***		***	***	***	

LEGEND

SV = Skill Variety
TS = Task Significance
FJ = Feedback from the Job
DO = Dealing with Others
MPS = Motivating Potential Score
TI = Task Identity
AU = Autonomy
FA = Feedback from Agents
df = degrees of freedom
std dev = standard deviation

*/** Navigator means based on the responses of 74 U.S. Air Force navigators/standard deviations not provided. Pilot sample standard deviations used (50:69).

*** Two-tailed t-test significant at a .05 alpha value.

the aircraft and mission type categories when the sample sizes are significantly less than thirty.

Urban compared the means of the JDS variables between the fighter-type and multi-place aircraft navigators and found that they were significantly different in only Skill Variety and Task Identity. Urban pointed out that, based on the definition of these two job dimensions, the variety of activities and the significance of the responsibilities shared with the pilot in the fighter-type aircraft are understandably higher than in the multi-place aircraft (50:66).

The comparison of means for pilot responses from fighter and multi-place aircraft is presented in Table 7. The T-TEST subprogram of SPSS-X was used for this comparison of means. A feature of the SPSS-X subprogram is indicated by the double asterisks above the T value for the Dealing with Others job dimension. SPSS-X computes two T values for the comparisons of a variable mean. One T value estimate is based on the assumption of equal variances in both samples (a pooled variance estimate) and the other is based on unequal variances (a separate variance estimate). When the ratio of the sample variances (F value) is significantly high, based on a predetermined alpha, the equal variance assumption is not valid. The F value for the Dealing with Others variable in Table 7 is 4.08. The separate variance estimate was used in this case for the T value of the

TABLE 7

PILOT COMPARISONS OF MEANS BY TYPE OF AIRCRAFT*

	SV	TI	TS	AU	FJ	FA	DO	MPS
MULTI-PLACE (n=83)								
means =	4.95	5.00	5.71	4.39	5.61	5.12	5.92	133.0
std dev =	0.99	0.96	0.97	1.04	0.84	1.07	0.73	54.5
FIGHTER-TYPE (n=10)								
means =	5.23	4.03	5.53	4.30	4.93	4.67	5.70	112.6
std dev =	1.39	0.94	0.98	1.01	1.23	1.07	1.45	54.4
							**	
T value =	-0.82	3.04	0.54	0.26	2.29	1.25	0.47	1.12
P value =	.414	.003	.588	.797	.024	.215	.648	.267
df=91		***			***		df=9.5	

LEGEND

SV = Skill Variety
TI = Task Identity
TS = Task Significance
AU = Autonomy
FJ = Feedback from the Job
FA = Feedback from Agents
DO = Dealing with Others
df = degrees of freedom
MPS = Motivating Potential Score
std dev = standard deviation

* Based on 93 pilot responses on navigator job characteristics.

** Two-tailed t-test T value and P value based on separate variance estimate.

*** Two-tailed t-test significant at a .05 alpha value.

means comparison for Dealing with Others and an estimate of the degrees of freedom is also provided.

The multi-place means presented in Table 7 for Task Identity and Feedback from the Job are significantly

higher than those of the fighter-type means. These results are similar to those reported by Urban from the navigator responses and seem to indicate that the navigator responsibilities in multi-place aircraft are more defined and not integrated with other duties, such as those of the weapon systems officer.

In comparing the pilots' response means with those for the navigators, Urban reported that Skill Variety and Task Significance means for the fighter-type navigators were significantly higher than those for the multi-place navigators. The navigator means for Task Identity, like the pilots in this study, were higher for multi-place aircraft, but not significantly, at Urban's .10 alpha value (50:69).

Analysis by Type of Mission. The types of mission categories were defined differently in this study when compared to Urban's mission categories. Based on the author's experience in various models of the C-135 aircraft and the NC-141A aircraft, the tanker and strategic airlift missions are probably diverse enough to be separated into two categories. For comparisons with Urban's research data, however, the tanker and strategic airlift missions were combined. Urban also defined a mission category for TEST/SPECIAL OPERATIONS, which is not compared in this study. No survey responses were received from pilots in this category and Urban's category had a sample size of only five (50:80).

The analysis of variance, or ANOVA, technique is ideally suited for multiple comparisons of means. The SPSS-X subprogram ONEWAY was used for means comparisons for the pilot's responses grouped by aircraft mission. Because only the means of Urban's navigator mission categories were available, the MathCAD procedure used in analyzing the comparison of means by type of aircraft was repeated for this analysis. Once again, the pilot's sample standard deviation was used as an estimate of the navigator's sample standard deviation. The comparison of means by types of mission are presented in Tables 8. Urban noted the decreased power of the t-test and the multiple comparisons of means (ANOVA) when the sample sizes were small (50:87). The sample sizes in all the categories presented for mission categories should be considered when analyzing the results of the comparisons. The lack of significance at the .05 alpha level is apparent between all the categories except for the tanker/strategic airlift mission. The fact that the pilots' means for Task Significance, Job Feedback, and Feedback from Agents are significantly higher than the navigator' responses may indicate that the pilots in these aircraft perceive the navigator's responsibilities as being more important than do the navigators. The relatively small sample size of 16 in the navigator category detracts from any assumptions that might be made, however. The higher value for autonomy and a MPS mean of 128.2 for the pilots

TABLE 8

COMPARISON OF MEANS BY TYPES OF MISSION

	SV	TI	TS	AU	FJ	FA	DO	MPS
				FIGHTER				
NAVS* (n=17)								
means = **	4.94	4.39	5.73	4.76	5.23	4.63	5.65	142.0
PILOTS(n=10)								
means =	5.23	4.03	5.33	4.30	4.93	4.66	5.70	112.6
std dev =	1.39	0.94	0.98	1.01	1.23	1.07	1.48	54.4
T value w/NAVS =	-0.52	0.96	1.02	1.14	0.61	-0.07	-0.09	1.36
P value =	.605	.346	.316	.265	.546	.945	.932	.186
df=25								
				TANKER/STRATEGIC AIRLIFT				
NAVS* (n=16)								
means = **	4.99	5.11	4.83	4.15	4.98	4.25	6.29	109.0
PILOTS(n=52)								
means =	4.83	4.96	5.62	4.38	5.56	5.06	5.83	128.2
std dev =	0.98	1.03	0.99	0.95	0.81	1.04	0.76	47.0
T value w/NAVS =	0.57	0.51	-2.79	-0.85	-2.51	-2.72	2.12	-1.43
P value =	.570	.612	.007	.398	.015	.008	.038	.157
df=66			***		***	***	***	

LEGEND

SV = Skill Variety
TI = Task Identity
TS = Task Significance
AU = Autonomy
FJ = Feedback from the Job
FA = Feedback from Agents
MPS = Motivating Potential Score
std dev = standard deviation

*/** Navigator means based on the responses of 74 U.S. Air Force navigators/standard deviations not provided. Pilot sample standard deviations used (50:69).

*** Two-tailed t-test significant at a .05 alpha value.

TABLE 8

COMPARISON OF MEANS BY TYPES OF MISSION (CONTD)

	SV	TI	TS	AU	FJ	FA	DO	MPS
STRATEGIC BOMBER								
NAVS* (n=28)								
means = **	5.43	5.13	5.90	4.50	5.56	5.06	6.39	141
PILOTS(n=16)								
means =	5.15	5.02	6.10	4.29	5.75	5.46	6.13	140.6
std dev =	0.94	0.77	0.69	1.25	0.96	1.16	0.71	68.1
T value w/NAVS =	0.95	0.46	-0.93	0.54	-0.63	-1.10	1.17	0.02
P value =	.348	.651	.360	.595	.531	.278	.249	.985
df=42								
TACTICAL AIRLIFT/RESCUE								
NAVS* (n=8)								
means = **	5.37	5.75	5.50	5.00	5.37	4.87	5.92	152
PILOTS(n=15)								
means =	5.16	5.16	5.62	4.51	5.64	4.96	6.04	141.6
std dev =	1.09	0.89	1.13	1.17	0.82	1.13	0.64	64.4
T value w/NAVS =	0.44	1.51	-0.24	0.96	-0.75	-0.18	-0.43	0.37
P value =	.664	.146	.810	.348	.460	.857	.673	.716
df=21								

LEGEND

SV = Skill Variety
TI = Task Identity
TS = Task Significance
AU = Autonomy
FJ = Feedback from the Job
FA = Feedback from Agents
DO = Dealing with Others
df = degrees of freedom
MPS = Motivating Potential Score
std dev = standard deviation

*/** Navigator means based on the responses of 74 U.S. Air Force navigators/standard deviations not provided. Pilot sample standard deviations used (50:69).

*** Two-tailed t-test significant at a .05 alpha value.

compared to 109.0 for the navigators is also noteworthy, although the differences were not statistical-ly significant. The larger sample size for pilots in this mission area may indicate increased validity in their response means.

The results presented in Table 9 reinforce the assumption of homogeneity among Air Force pilots. The ONEWAY subprogram for SPSS-X, using Tukey's multiple range test for the pilots' responses by mission category, identified only one job dimension, Task Identity, in one mission category, Tactical Airlift/Rescue, as significantly different from the other job dimensions for that category.

The results in Table 9 also indicate that 34 of the 52 tanker/strategic airlift responses in Table 8 are from tanker pilots. The differences in the means of tanker and strategic airlift pilots' responses in Table 9 are not significant using ANOVA, yet the tanker pilot means are higher than those of strategic airlift pilots in all job dimensions, except Task Identity.

The T-TEST subprogram of SPSS-X revealed a disparity with the Tukey's test of ANOVA. A two-sample comparison of the Job Feedback means for tanker and strategic airlift pilots indicates their respective means of 5.73 and 5.24 are significantly different at a .05 alpha value. The t-test indicates a T value of 2.11 and a P value of .040 using a degrees of freedom equal to 50. Kachigan points out that, in order for ANOVA to measure variation between the means, an assumption of equal variances must be made (24:280).

TABLE 9

PILOT COMPARISONS OF MEANS FOR TYPES OF MISSION

	SV	TI	TS	AU	FJ	FA	DO	MPS
FIGHTER(n=10)								
means =	5.23	4.03	5.53	4.30	4.93	4.67	5.70	112.6
std dev =	1.39	0.94	0.98	1.01	1.23	1.07	1.45	54.4
TANKER (n=34)								
means =	4.92	4.92	5.66	4.51	5.73	5.25	5.86	135.6
std dev =	0.97	1.07	0.98	0.92	0.74	0.97	0.80	44.7
					*			
STRAT ALFT(n=18)								
means =	4.65	5.02	5.50	4.15	5.24	4.70	5.76	114.2
std dev =	1.01	0.99	1.02	0.98	0.87	1.10	0.69	49.4
					*			
TC ALFT/RS(n=15)								
means =	5.16	5.16	5.62	4.51	5.64	4.96	6.04	141.6
std dev =	1.09	0.89	1.13	1.17	0.82	1.13	0.64	64.4
		**						
STRAT BOMB(n=16)								
means =	5.15	5.02	6.10	4.29	5.75	5.46	6.13	140.6
std dev =	0.94	0.77	0.69	1.25	0.95	1.16	0.70	68.1

LEGEND

SV = Skill Variety
TI = Task Identity
TS = Task Significance
AU = Autonomy
FJ = Feedback from the Job
FA = Feedback from Agents
DO = Dealing with Others
df = degrees of freedom
MPS = Motivating Potential Score
std dev = standard deviation

* Two-tailed t-test indicates significance at .05 alpha.

** Based on Tukey's multiple range test for ANOVA. Significant at a .05 alpha value.

Type II errors are also more difficult to calculate using ANOVA. The t-test comparison of the Job Feedback values may be a better measurement in this case.

This difference in the responses for Job Feedback is perhaps better measured qualitatively than quantitatively. As the earlier comments from C-141 pilots indicated, the navigator's strategic airlift mission is insignificant, except for the special operations low level flights. The following comments from KC-135 pilots indicate that, although the navigator is not required for routine navigation, the wartime mission of the KC-135 may provide more significance for the navigator.

A KC-135 Copilot, 1LT, 26-30 years old with 1100 total hours and no supervisory experience (MPS = 120.9, CPS = 93.3) emphasized,

> New fighter weapons systems are hard to employ, thus task saturating the pilot (I feel that we should rethink our strategy on single seat fighters). On multi-place airplanes, navigators are virtually replaced by the triple INS. A good flight engineer is probably all one needs. That is, until all navigation aids are knocked out by EMP (electromagnetic pulse), --making the navigator a very important crewmember.

A KC-135 Flight Commander, captain, 26-30 years old with 1650 total flight hours and navigator supervisory experience (MPS = 122.7, CPS = 128.0) pointed out,

> If the Air Force were only in the business of transporting passengers and cargo from one destination to another on established jet routes, I would agree there is not a great need for them. Fortunately, we are expected to perform much more demanding missions. In the KC-135, the pilot and copilot could possibly take over his role, but only with great expenditure for more equipment and a decrease in overall safety. In more complicated aircraft with more demanding and time compressed missions, I could not imagine an aircraft without a navigator to be as effective or safe.

A KC-135A STAN/EVAL Pilot, 1Lt, 26-30 years old with 950 total hours and no supervisory experience (MPS = 117.9, CPS = 51.9) stressed,

> The war capabilities of the nav/WSO are a vital asset. During peace time conditions, especially in non-threat environments such as air refueling and cargo drags, the navigation skills can be assumed by the pilot. This is already proven in the KC-10. Since our profession is war, the nav/WSO assets are too valuable to go without!

Analysis by Rank and Supervisory Experience. The second research objective was designed to analyze any significance associated with the military experience (rank) and navigator supervisory experience of the respondent. The assumption, based on the author's experience, is that possible differences in pilot perceptions of navigator job satisfaction may be dependent on both military experience and experience as a navigator supervisor. The second investigative question evaluated this objective:

2. How does the pilot's overall military experience, determined by rank, and supervisory experience with navigators relate to whether a need for navigator job redesign is indicated in the results of the JRF data?

Two problems associated with this question which the survey questionnaire did not address are:

1. What is the definition of a "supervisor?" The military definition most often used is that a supervisor is the individual who writes one's performance report, the "rater." Pilots, particularly first lieutenants, may consider acting as the aircraft commander as supervisory. This

interpretation was noted on some of the survey responses. To eliminate confusion, those with less than 1000 hours total flying time in multi-place aircraft were considered as non-supervisors. In retrospect, a better term, "reporting official," would have been indicative of the data needed.

2. The rank of captain is held for approximately eight years. A senior captain probably has more experience than a junior captain. The subcategory is large compared to those for major and first lieutenant which is good for generalizability, but poor for comparison of experience levels. A "time in grade" question would have been more helpful than the "number of individuals supervised" question, which was not used in this data analysis.

The ANOVA comparison of means by rank is presented in Table 10. Independent two sample t-tests between the ranks were performed to confirm the lack of significance of any of the differences at the .05 alpha value. The means for first lieutenants are higher than those of either captains or majors in all the job dimensions. The higher means for lieutenants in both Autonomy and Job Feedback account for the higher MPS mean. The higher values are to be expected considering the fact that most first lieutenants are still copilots. Krebs reported in his research that copilots have a lower MPS value than any other crewmember (25:124). Copilots are completely dependent on the aircraft commander for their job responsibilities. From the copilots'

TABLE 10

PILOT COMPARISON OF MEANS
BY AGE AND MILITARY EXPERIENCE

	SV	TI	TS	AU	FJ	FA	DO	MPS
RANK*								
MAJOR (n=23)								
means =	4.87	4.97	5.78	4.32	5.45	4.77	6.09	128.2
std dev =	1.04	0.94	0.83	1.07	1.02	1.10	0.74	54.2
CAPT (n=52)								
means =	5.03	4.82	5.71	4.27	5.51	5.17	5.85	126.1
std dev =	1.10	1.07	1.05	0.97	0.83	0.96	0.92	51.7
1ST LT(n=18)								
means =	4.96	5.04	5.52	4.78	5.72	5.17	6.09	147.8
std dev =	0.88	0.85	0.94	1.13	0.97	1.34	0.74	62.6
AGE CATEGORY								
30/BELOW (n=56)								
means =	5.04	4.90	5.73	4.38	5.67	5.29	5.99	134.2
std dev =	1.06	1.01	0.98	1.05	0.84	1.08	0.79	56.2
ABOVE 30 (n=37)								
means =	4.89	4.90	5.63	4.38	5.34	4.73	5.77	125.6
std dev =	1.02	0.99	0.97	1.02	0.97	1.00	0.90	52.2
T value =	0.65	-0.01	0.49	0.01	1.71	2.53	1.26	0.75
P value =	.516	.992	.624	.991	.090	.013	.210	.458
df = 91						**		

LEGEND

SV = Skill Variety	TI = Task Identity
TS = Task Significance	AU = Autonomy
FJ = Feedback from the Job	FA = Feedback from Agents
DO = Dealing with Others	df = degrees of freedom
MPS = Motivating Potential Score	std dev = standard deviation

* Based on Tukey's multiple range test for ANOVA.

** Two-tailed t-test significant at a .05 alpha value.

perspective, most of the other crewmembers have more autonomy and job feedback than they.

Also presented in Table 10 is a two-sample t-test for age. This comparison of respondents above thirty years of age with those thirty years old and younger was an attempt to compare differences within the large sample of captains. By dividing the responses in this manner, 38 of the captains were included with the lieutenants in the thirty and below category. As indicated in Table 10, the means of the younger pilot category were equal to or greater than those of pilots over thirty in all job dimensions. The Feedback from Agents response mean was significantly greater for the younger pilots than for those over thirty.

Table 11 displays the comparison of means for the MPS and job dimensions of supervisors and non-supervisors (observers). As discussed in Chapters I and II, the primary purpose for Hackman and Oldham's JRF is for comparison of the worker's perception of the job with those of supervisors or outside observers. No significant differences are presented in Table 11 between the pilot supervisors and observers for any of the job dimensions or the MPS. This apparent homogeneity between supervisor and non-supervisor pilots may indicate the difficulty in defining the copilot as an "outside observer." All pilots may respond more as supervisors and future supervisors rather than as supervisors and observers as Hackman and Oldham predicted.

TABLE 11

COMPARISON OF MEANS FOR SUPERVISORS AND OBSERVERS*

	SV	TI	TS	AU	FJ	FA	DO	MPS
SUPERVISORS (n=55)								
means =	4.96	4.95	5.74	4.30	5.59	5.09	5.81	130.2
std dev =	1.15	0.98	0.99	1.07	0.89	1.02	0.94	54.7
OBSERVERS (n=38)								
means =	5.00	4.83	5.62	4.50	5.46	5.04	6.03	131.7
std dev =	0.86	1.02	0.95	0.99	0.92	1.18	0.64	55.1
T value =	-0.17	0.53	0.57	-0.93	0.64	0.24	-1.22	-0.13
P value =	.869	.596	.572	.355	.521	.808	.225	.898
df=91								

LEGEND

SV = Skill Variety
TI = Task Identity
TS = Task Significance
AU = Autonomy
FJ = Feedback from the Job
FA = Feedback from Agents
DO = Dealing with Others
df = degrees of freedom
MPS = Motivating Potential Score
std dev = standard deviation

* Based on 93 pilot responses on navigator job characteristics.

As discussed in Chapter III, the third step of Hackman and Oldham's five step diagnostic analysis for job redesign is to identify "the specific strengths or weaknesses of the job as it currently exists" (18:34). A profile of the job under consideration can be constructed to visually compare the five core job dimensions as they are perceived by the worker, supervisor, and any additional observers of the job. As Hackman and Oldham pointed out, when the shape of the

worker's JDS profile is similar to JRF profile of the supervisor, planning for change may proceed with little reason for concern (19:115). However, when employees and supervisors disagree about what are the relatively best and worst aspects of the job, the values for the job core dimensions will fluctuate between greater than and less than the other and the job profile will not be similar. If this is the case, additional data are required before job redesign. As previously discussed, the perceptions of the outside observers may fit well with either those of the employees or those of the supervisors.

Table 12 presents the means comparisons for the supervisor and observer categories with the navigator response means from Urban's study. As indicated in Table 12, the supervisors' mean for Feedback from Agents is significantly higher than that of the navigators while the navigators' mean for Dealing with Others is significantly higher than that of the supervisors. Although there are no significant differences between the navigator and observer means, the job profiles illustrated in Figure 6 (a) and (b) indicate that neither the supervisor nor observer pilots' responses fit the navigator job profile as Hackman and Oldham predicted (19:115). Data obtained from non-rated crewmembers may provide a better representation of Hackman and Oldham's outside observer category.

TABLE 12

COMPARISON OF MEANS OF NAVIGATORS WITH SUPERVISORS AND OBSERVERS

	SV	TI	TS	AU	FJ	FA	DO	MPS
SUPERVISORS* (n=55)								
means =	4.96	4.95	5.74	4.30	5.59	5.09	5.81	130.2
std dev =	1.15	0.98	0.99	1.07	0.89	1.02	0.94	54.7
NAVS** (n=74)								
means =	5.23	4.97	5.58	4.59	5.29	4.60	6.14	135.6
std dev =	1.12	1.18	1.27	1.23	1.03	1.42	0.83	61.3
T value w/SUPVRS =	-1.34	-0.10	0.78	-1.40	1.73	2.18	-2.11	-0.52
P value =	.183	.921	.437	.164	.086	.031	.037	.604
df=127						***	***	
OBSERVERS* (n=38)								
means =	5.00	4.83	5.62	4.50	5.46	5.04	6.03	131.7
std dev =	0.86	1.02	0.95	0.99	0.92	1.18	0.64	55.1
T value w/NAVS =	1.11	0.62	-0.17	0.39	-0.86	-1.64	0.72	0.33
P value =	.269	.537	.865	.697	.392	.104	.473	.742
df=110								

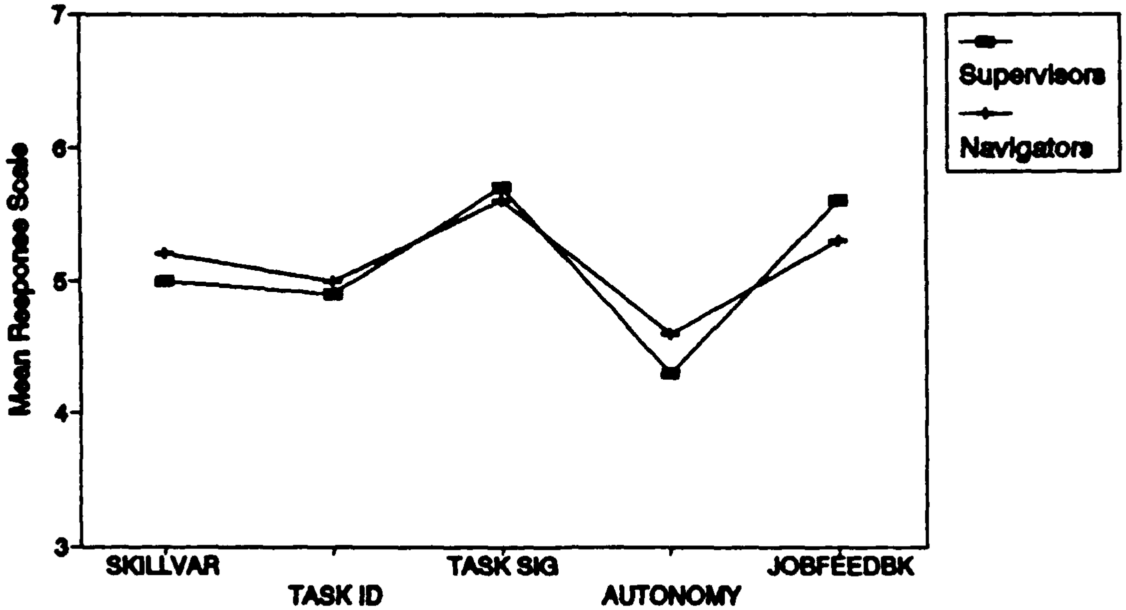
LEGEND

SV = Skill Variety
TI = Task Identity
TS = Task Significance
AU = Autonomy
FJ = Feedback from the Job
FA = Feedback from Agents
DO = Dealing with Others
df = degrees of freedom
MPS = Motivating Potential Score
std dev = standard deviation

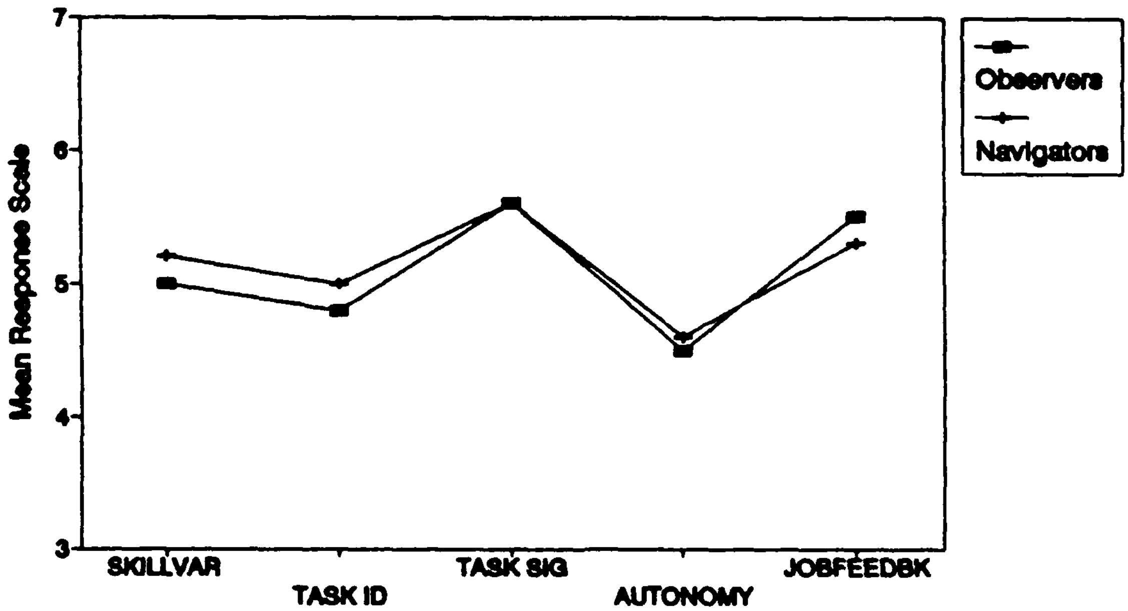
* Based on 93 pilot responses on navigator job characteristics.

** Navigator means based on the responses of 74 U.S. Air Force navigators (50:69)

*** Two-tailed t-test indicates significance at .05 alpha.



(a) Navigator/Supervisor Job Profiles



(b) Navigator/Observer Job Profiles

Figure 6. Job Profile Comparisons of Navigator and Pilot Supervisor/Observer Survey Results.

Analysis of the Command Potential Model

The last research objective was the basis for the nine additional questions added in section three of the survey questionnaire. It attempted to ascertain the pilot's perception of how well the navigator could perform as a mission commander. This objective was deemed to be a logical extension of the navigator redesign recommendation from Urban's research and was evaluated with the two-part third investigative question:

> 3. What is the pilot's perception of the value and continued requirement for the navigator career field? How does this value perception compare to the pilot's attitude toward surrendering mission commander responsibility to a more experienced, senior navigator?

As discussed in Appendix D, the reliability and validity of the Section Three questions needed to be evaluated before the command potential attributes could be analyzed. The RELIABILITY subprogram of SPSS-X was used to calculate various equivalence and homogeneity coefficients for the complete survey instrument. The PEARSON CORR subprogram was used for measuring the intercorrelations exhibited by the various attributes.

Cronbach's coefficient alpha was .88 for the entire questionnaire. For the nine questions of Section Three, a .83 Cronbach's alpha was computed with a Guttman split-half coefficient of .83 and a .84 value for the unequal length Spearman-Brown coefficient. Reliability measures above .80

for this type of questionnaire are considered satisfactory (18:37).

Intercorrelations of the Section Three questions with each other and the job dimension variables are presented in Table 13. SPSS-X provides two-tailed test P values for .01 and .001 levels of significance. Absolute r values are indicated at the bottom of the table for these significance levels. A P value of .01 is considered moderately significant for this correlational analysis, while .001 is considered highly significant.

TABLE 13

INTERCORRELATIONS OF SECTION THREE
QUESTIONS AND JOB SATISFACTION DIMENSIONS

	SECTION THREE QUESTIONS								
	#1	#2	#3	#4	#5	#6	#7	#8	#9
Skill Variety	.25	.47	.36	.29	.16	.25	.34	.17	.18
Task Ident	-.01	.10	.21	.12	.06	.13	.17	.11	.06
Task Signif	-.01	.36	.49	.39	.17	.29	.43	.22	.05
Autonomy	.20	.27	.32	.16	.16	.10	.17	.23	.09
Fdbk Job	.13	.17	.17	.17	.03	.03	.17	.04	-.05
Fdbk Agents	.08	.08	.10	.09	-.07	-.08	.13	.03	-.03
Deal Othrs	.10	.23	.22	.28	.10	.14	.22	.11	-.08
MPS	.18	.37	.39	.23	.17	.16	.29	.22	.09
Question #1	---	.40	.34	.22	.32	.18	.27	.23	.09
Question #2		---	.61	.53	.32	.53	.56	.35	.33
Question #3			---	.70	.38	.48	.58	.39	.23
Question #4				---	.42	.43	.46	.39	.25
Question #5					---	.24	.32	.49	.26
Question #6						---	.27	.26	.11
Question #7							---	.38	.35
Question #8								---	.26
Question #9									---

Two-tailed tests for r > .26, p = .01; r > .32, p = .001

As expected, the responses to the nine added questions indicate highly significant correlations between some of the questions and some of the job dimensions. This interdependence is also exhibited in the JDS and JRF questions (19:313). As indicated in Table 13, questions 2, 3, 4, and 7 have high levels of correlation with each other and the job dimensions of Skill Variety and Task Significance. These intercorrelation coefficients were considered in the assessment of which questions would be used to calculate the command potential attributes of Retain, Value, and Mission. As previously discussed, the product of these three means equals the CPS value.

Table 14 presents the intercorrelations of all the job dimensions, command potential attributes, MPS, and CPS for the 93 pilot responses to the survey questionnaire. As expected, the MPS and CPS exhibit high levels of interdependence with the core job dimensions and command potential attributes.

An important observation in Table 14 is the high correlation of the three command potential attributes with Skill Variety, Task Significance, and the MPS. These correlations may indicate that the Section Three questions measure similar characteristics to those measured by the Skill Variety and Task Significance job dimensions. However, more sampling would have to be analyzed to test the hypothesis.

TABLE 14

INTERCORRELATIONS OF JOB DIMENSIONS
AND COMMAND POTENTIAL ATTRIBUTES

	2	3	4	5	6	7	8	9	10	11	12
1. SkillVar	.06	.58	.45	.38	.23	.40	.61	.47	.28	.26	.39
2. Task Id	---	.28	.21	.40	.32	.26	.47	.12	.18	.12	.14
3. Task Sig		---	.18	.44	.36	.49	.54	.36	.36	.32	.34
4. Autonomy			---	.37	.41	.29	.83	.27	.23	.23	.29
5. Feedback Job				---	.66	.49	.72	.20	.06	.10	.09
6. Feedback Agents					---	.33	.62	.13	-.01	.01	.02
7. Dealing with Others						---	.46	.25	.12	.20	.18
8. Motivating Potential Score							---	.37	.28	.26	.33
9. Retain								---	.66	.57	.82
10. Value									---	.61	.89
11. Mission										---	.75
12. Command Potential Score											---

Two-tailed tests for $\underline{r} > .26$, $p = .01$; $\underline{r} > .32$, $p = .001$

Intercorrelations for the job dimensions, command potential attributes, MPS, and CPS responses of supervisors and observers are presented in Tables 15 and 16, respectively. The high correlation of the CPS value with the MPS value in Table 14 is significant when compared to the same values in Tables 15 and 16. The correlation of the CPS construct with the MPS for the pilot supervisors is highly significant compared to that of the observers. The high interdependence between supervisor and navigator MPS and CPS means may indicate an association between the recognition of command potential for navigators by their supervisors that is not apparent with the outside observer.

TABLE 15

INTERCORRELATIONS OF JOB DIMENSIONS AND
COMMAND POTENTIAL ATTRIBUTES FOR SUPERVISORS

	2	3	4	5	6	7	8	9	10	11	12
1. SkillVar	.11	.59	.49	.46	.31	.46	.68	.47	.28	.29	.41
2. Task Id	---	.36	.20	.38	.23	.31	.44	.24	.27	.21	.24
3. Task Sig		---	.22	.48	.43	.60	.57	.33	.39	.27	.34
4. Autonomy			---	.28	.37	.24	.85	.29	.28	.41	.40
5. Feedback Job				---	.63	.61	.65	.12	.04	.15	.09
6. Feedback Agents					---	.35	.58	.15	.15	.25	.22
7. Dealing with Others						---	.51	.22	.12	.30	.21
8. Motivating Potential Score							---	.38	.34	.40	.43
9. Retain								---	.71	.49	.84
10. Value									---	.59	.91
11. Mission										---	.72
12. Command Potential Score											---

Two-tailed tests for $r > .33$, $p = .01$; $r > .42$, $p = .001$

TABLE 16

INTERCORRELATIONS OF JOB DIMENSIONS AND
COMMAND POTENTIAL ATTRIBUTES FOR OBSERVERS

	2	3	4	5	6	7	8	9	10	11	12
1. SV	-.04	.57	.40	.24	.10	.25	.50	.46	.29	.27	.38
2. TI	---	.16	.23	.44	.43	.21	.50	-.05	.01	.02	-.01
3. TS		---	.15	.36	.26	.29	.49	.41	.30	.37	.34
4. Autonomy			---	.52	.49	.38	.83	.25	.20	.06	.14
5. Feedback Job				---	.71	.33	.83	.32	.07	.03	.06
6. Feedback Agents					---	.35	.66	.10	-.26	-.20	-.25
7. Dealing with Others						---	.40	.32	.20	.13	.16
8. Motivating Potential Score							---	.35	.20	.14	.19
9. Retain								---	.62	.67	.82
10. Value									---	.67	.87
11. Mission										---	.81
12. Command Potential Score											---

Two-tailed tests for $r > .41$, $p = .01$; $r > .50$, $p = .001$

LEGEND

SV = Skill Variety　　TI = Task Identity
TS = Task Significance

Intuitively, this association would be expected because the supervisor is more cognizant of the significance of the navigators responsibilities. However, as previously discussed, the weakness in this assumption is the interpretation of a non-supervisor pilot as an observer. Additional survey analysis of larger sample sizes are necessary before an assumption of the association between the MPS and CPS measurements could be confirmed. In Table 14 it is also noted that the MPS to CPS correlation was highly significant when all the pilot responses were considered.

Responses from other outside observers could also be used to strengthen or disclaim the apparent association of the MPS and CPS values for supervisors.

Perception of Command Potential. The previous discussion the attributes for command potential acknowledged that they were not intended to be completely independent of each other; this interdependence is confirmed by the correlation analysis. The primary purpose of the attributes is to be used in the calculation of the CPS value:

Command Potential Score (CPS) = Retain X Value X Mission

A completely unbiased value for the CPS could be calculated by averaging all the Section Three responses and multiplying by three. However, this "pure" CPS value would not have the significant "clustering effect" associated with

the qualitative differences in the nine added questions. The use of the attributes does not significantly affect the numerical value of the CPS because the computation of a "pure" CPS mean, as described above, for all pilot responses would yield a value of 119.7 instead of the 115.4 mean value used in this study.

Another advantage for using the attributes for command potential is to alleviate the requirement to analyze each of the nine addition survey questions individually. Two of the Section Three questions, however, should be considered separately because of the contrast they provide in the analysis of the third investigative question. Questions eight and nine replicate the intent of the two-part investigative question:

8. An experienced navigator/WSO who makes mission-related decisions will better enable the pilot to make correct decisions concerning flight safety issues.

9. On multi-place aircraft, the senior rated officer (assuming equal or greater flight experience) should be designated as mission commander, even if it is the navigator/WSO, as long as his or her duties do not conflict with those of the aircraft commander.

In retrospect, these two questions should not have been placed consecutively in the questionnaire. They obviously address the same issue from two different viewpoints. The issue is the third research objective and its two-part investigative question represents the viewpoints:

3. What is the pilot's perception of the value and continued requirement for the navigator career field? How does this value perception compare to the pilot's attitude toward surrendering mission commander responsibility to a more experienced, senior navigator?

The irony of placing the "two viewpoint" questions in consecutive order in the survey instrument is the difference exhibited in the mean response of all the pilots to question eight (5.48) in comparison with their mean response to question nine (2.65).

Tables 17 and 18 present the analysis of the comparisons of means for questions eight and nine, and the attributes of the Command Potential Model. Comparisons for the supervisor and observer categories are presented in Table 17 while those made by rank and age categories are found in Table 18. The CPS and MPS means are also presented in Tables 17 and 18 for comparison purposes. While neither difference for these two variables is significant at a .05 alpha value, the observer response means would be significantly lower with a .10 alpha.

The differences in the question nine and Value responses in Table 18 are not as large for the comparisons by age and rank. However, the differences between the question eight and nine responses are readily apparent. The only significant differences in Table 18 is in the question eight and Mission means between captains and first lieutenants. The CPS mean for captains is higher than any

TABLE 17

COMPARISON OF COMMAND POTENTIAL ATTRIBUTES

QUESTION	Q3.8	Q3.9	RETAIN	MISSION	VALUE	CPS	MPS
SUPRVSRS (n=55)							
mean =	5.53	2.93	5.06	5.16	4.21	121.6	130.2
std dev =	1.23	2.02	1.24	0.98	1.28	71.4	54.7
OBSRVRS (n=38)							
mean =	5.42	2.24	5.06	4.95	3.78	106.3	131.7
std dev =	1.62	1.60	1.23	1.40	1.08	66.5	55.1
T value =	0.36	1.76	0.00	0.85	1.85	1.04	-0.13
P value =	.720	.082	.998	.396	.068	.300	.898
df = 91							

other category, although the mean response for question nine is higher for majors and those over thirty.

The first lieutenants responded with the lowest CPS, Mission, and Value mean of all categories. The low scores for lieutenants are to be expected because they would have the most to surrender in the area of command authority. If more lieutenants are copilots, they have the most to lose in giving up command authority which they have not yet obtained. As the following comments indicate, first lieutenants recognize a need to retain navigators yet they do not think that navigators have the proper "training" to assume command.

A KC-135 Copilot, 1Lt, under 26 with 516 total hours and no supervisory experience (MPS = 243.5, CPS = 132.2),

> I do feel strongly about question #9. The aircraft commander <u>is</u> the mission commander. He was <u>trained</u> for this, the <u>navigator</u> was <u>not</u>. The aircraft commander has the controls in his <u>hands</u>, he needs to make the decisions as to what to do with them.

TABLE 18

COMPARISON OF SECTION THREE QUESTIONS AND COMMAND POTENTIAL ATTRIBUTES BY AGE AND RANK

	Q3.8	Q3.9	RETAIN	MISSION	VALUE	CPS	MPS
30/BELOW (n=56)							
mean =	5.59	2.45	5.17	5.10	3.92	115.8	134.2
std dev =	1.35	1.79	1.21	1.22	1.21	70.2	56.2
OVER 30 (n=37)							
mean =	5.32	2.95	4.90	5.03	4.18	114.8	125.6
std dev =	1.47	2.00	1.26	1.10	1.22	69.3	52.2
T value =	0.90	-1.26	1.02	0.30	-1.03	0.07	0.75
P value =	.373	.212	.311	.766	.308	.947	.458
df = 91							
MAJOR (n=23)							
mean =	5.30	2.83	4.74	5.03	4.07	104.6	128.2
std dev =	1.43	2.08	1.21	0.98	1.16	54.3	54.2
CAPTAIN (n=52)							
mean =	5.75	2.67	5.26	5.29	4.06	124.9	126.1
std dev =	1.12	1.84	1.22	1.02	1.22	72.7	51.7
T value =	-1.46	0.32	-1.74	-1.06	0.05	-1.20	0.16
P value =	.149	.751	.086	.295	.961	.235	.876
df = 73							
FIRST LT (n=18)							
mean =	4.94	2.33	4.87	4.48	3.85	101.6	147.8
std dev =	1.89	1.78	1.25	1.58	1.31	76.1	62.6
T value w/MAJOR =	0.69	0.80	-0.34	1.36	0.57	0.14	-1.07
P value =	.492	.428	.735	.182	.570	.886	.289
df = 39							
T value w/CAPT =	2.18	0.68	1.19	2.52	0.60	1.16	-1.45
P value =	.033	.499	.238	.014	.548	.252	.151
df = 68	**			**			

LEGEND

df = degrees of freedom
CPS = Command Potential Score
MPS = Motivation Potential Score
std dev = standard deviation

* Based on 93 U.S. Air Force pilot responses

** Two-tailed t-test significant at a .05 alpha value.

A KC-135 Pilot, 1Lt, under 26 years old with 800 total flight hours and no supervisory experience (MPS = 168.0, CPS = 80.0) pointed out,

> Although navs are a great benefit to KC-135 operations and highly experienced navs help immensely in mission decisions, I don't feel they have the training or knowledge to make mission decisions (i.e. aircraft performance, fuel burn, divert for weather, pilot abilities in the weather, etc.).

No significant difference was observed for the CPS values of any categories in Tables 17 and 18. This may be considered as another example of the homogeneity of the sample. However, the fact that the CPS mean value in all categories was above 64.0 is significant. The value of 64 is as high as the CPS could be if all question responses averaged a value of 4.0 or less indicating the respondent answered the question as being "uncertain" or "inaccurate" to some degree.

Theoretically, if the CPS mean is significantly above 64, the pilot's perception of navigator command potential may be considered to be positive. By treating the 64 CPS value as a perfect "uncertainty" or lack of correlation, values above 64 could be considered positively correlated.

Perhaps Table 19 presents a better approach for evaluating the third research objective by its consideration of the two "viewpoint" question. The inconclusiveness of the CPS construct is avoided if the responses to only questions eight and nine are evaluated to analyze investigative question three. Each category of pilots'

TABLE 19

COMPARISON OF RESPONSE MEANS FOR
SECTION THREE QUESTIONS EIGHT AND NINE

	QUESTIONS:	EIGHT	NINE	T VALUE /	P VALUE
PILOTS	means =	5.48	2.65	8.99	.000
(n=93)	std dev =	1.40	1.88		****
SUPERVISORS	means =	5.53	2.93	8.15	.000
(n=55)	std dev =	1.23	2.02		****
OBSERVERS	means =	5.42	2.24	8.61	.000
(n=38)	std dev =	1.62	1.60		****
THIRTY/BELOW	means =	5.59	2.45	10.48	.000
(n=56)	std dev =	1.35	1.79		****
ABOVE THIRTY	means =	5.32	2.95	5.81	.000
(n=37)	std dev =	1.47	2.00		****
MAJORS	means =	5.30	2.83	4.69	.000
(n=23)	std dev =	1.43	2.08		****
CAPTAINS	means =	5.75	2.67	10.31	.000
(n=52)	std dev =	1.12	1.84		****
FIRST LTS	means =	4.94	2.33	4.27	.000
(n=18)	std dev =	1.89	1.78		****
MULTI-PLACE	means =	5.58	2.60	11.86	.000
(n=83)	std dev =	1.32	1.87		****
FIGHTER-TYPE	means =	4.70	3.00	1.98	.032
(n=10)	std dev =	1.83	2.00		****
TANKER	means =	5.44	1.68	12.71	.000
(n=34)	std dev =	1.42	0.98		****
STRAT AIRLIFT	means =	5.28	2.33	5.39	.000
(n=18)	std dev =	1.49	1.78		****
TAC AIRLIFT/	means =	6.07	4.13	3.05	.002
RESCUE (n=15)	std dev =	0.88	2.30		****
STRAT BOMBER	means =	5.75	3.44	4.20	.000
(n=16)	std dev =	1.18	1.86		****

LEGEND

std dev = standard deviation
**** One-tailed t-test significant at a .05 alpha value.

responses used in this study is presented with a one-tailed t-test of the means for questions eight and nine. The one-tailed test is used because the direction of the inequality is obvious from these comparisons.

The interpretation of the results presented in Table 19 may not be as obvious as the outcome of the t-tests. However, using the two viewpoint relationship in examining investigative question three, the value and need for retaining the navigator for flight safety and mission accomplishment apparently is rated high while the potential for surrendering command responsibility is low.

Summary

This chapter has presented a detailed analysis of the response data obtained from the survey questionnaires. Demographic descriptions of the survey sample and the response rates of the pilot categories were discussed. Indepth descriptions of the analysis procedures and comparisons with Urban's navigator response data were presented. The analysis of each of the three investigative questions used to evaluate the research objectives was also described. The final chapter presents the conclusions from this study's analysis plan and recommendations for additional research.

V. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents an overview of the key issues identified in the data analysis of the previous chapter. First, the limitations of the analysis plan are briefly reviewed. Conclusions derived from the two stages of the diagnostic analysis plan described in Chapter III are then presented to perform a final evaluation of the research objectives. Recommendations for the navigator career field, both now and in the future, are presented. Recommendations for further research are also provided.

Additional Limitations of the Analysis

Before discussing the conclusions that can be derived from the analysis of the survey response data, the probable weaknesses in the research design of this study should be reviewed. As discussed in Chapter IV, the pilots' comments provide qualitative insight into their perceptions which cannot be gained from the quantitative analysis of the MPS and CPS values. To reinforce these quantitative measurements, selected comments are provided throughout Chapters IV and V along with a biographical sketch of the respondent. The MPS and CPS values are also provided with each comment for comparison purposes only. Additional comments are contained in Appendix G.

One weakness in this analysis, pointed out by some of the pilots, is that the comparison of job satisfaction for both navigators and weapon system operators in the same survey is sometimes contradictory.

A C-141, Chief of Standardization/Evaluation, major, 31-35 years old with 2900 total hours and navigator supervisory experience (MPS = 82.9, CPS = 42.7) suggested,

> Greater differentiation needs to be made between navigators (heavies) and WSO (fighters). I believe the extra set of eyes in a fighter is critical to survival. The necessity of a navigator in a cargo aircraft is less clear.

An F-111 Fighter Weapons School Instructor, captain, 31-35 years old with 2000 total hours and navigator supervisory experience (MPS = 196.4, CPS = 115.6) stated,

> I feel advanced navigation systems enhance the role of the WSO. In the night low level environment a WSO is critical due to the task saturating nature of the mission. Lumping together navigators from heavy aircraft and WSOs from fighters in a survey is absurd and appears to have no credibility.

An obvious difference does exist between the mission requirements of the WSO and those of the navigator in the multi-place aircraft. More importantly, however, the responses from this study, as well as those in Urban's research, should underscore the point that there may be four or five different navigator requirements in the Air Force. Because the inventory consists of aircraft designed for various missions, manufactured years apart, and equipped with navigation equipment built from different generations

of technology, navigator requirements may not depend only on how many crewmembers are required to operate the aircraft.

The strategic airlift mission and inertial navigation equipment of the C-141B do not require the expertise of a navigator. However, when the C-141 is tasked to perform a more tactical, low level mission, the expertise of the navigator is perhaps mandatory. The weather radar and INS capability of the C-141 are not sufficient for low level navigation. The tanker air refueling mission may not require the efforts of a navigator, but SAC does not train or sit "alert" for a peacetime mission.

A KC-135A Pilot, 1Lt, 26-30 years old with 950 total hours and no supervisory experience (MPS = 117.9, CPS = 51.9) observed,

> The war capabilities of the nav/WSO are a vital asset. During peacetime conditions, especially in non-threat environments such as air refuelings and cargo drags, the navigation skills can be assumed by the pilot. This is already proven in the KC-10. Since our profession is war, the nav/WSO assets are too valuable to go without!

The four or five navigator missions in the Air Force are perhaps more diverse than the aircraft in which the navigators are trained to fly. Contingencies for war compound the complexity of the various navigator missions. The results of this study should emphasize Urban's contention that an aggregate study of navigator job satisfaction may not be conclusive (50:98).

Cross-Sectional Analysis. The most significant limitation of this research is the type of data analysis it provides. Correlational, or cross-sectional, analysis does not usually lead to causal inferences (11:78). Perhaps the only inferences that can be made from self-report survey analyses are those which recognize the degree of association between two or more variables. As discussed in Chapter II, Porter and Lawler argued that performance leads to job satisfaction instead of the popular antithesis that job satisfaction leads to performance.

Because few controls can be placed on survey responses, causal relationships may be impossible to define due to the "confounding impact of extraneous variables" (11:78). Hackman and Oldham recognized this limitation when they emphasized the importance of a "multiple method" approach to the study of job redesign (19:102). The JRF is just one of numerous methods of obtaining additional data to supplement the data provided by the JDS. Interviews and personal observations are also suggested as methods of analysis.

Several techniques are available to improve the results obtained through correlational analysis (42). This study attempted to take advantage of some of those techniques. One technique, the use of larger sample sizes, is not always practical or permitted by the approval authority. Using stratified samples is a technique that was attempted but, if the sample sizes are not controlled *a priori*, the results are difficult to generalize upon a larger population.

Relating the correlation data to other 'hard' measures, such as actual turnover or absentee rates, is another technique for improving survey results (42). The 'hard' measures associated with the navigator career field are somewhat contradictory. Navigators have the highest retention rate of any officer career field in the Air Force and the lowest promotion rate to lieutenant colonel. Perhaps the lack of civilian flying career opportunities is the reason for high retention among navigators and the lack of early command opportunities may explain the low promotion rates beyond major.

The First Stage of the Analysis Plan

The first stage of the analysis plan for this study was to supplement the results of Urban's previous research of navigator job satisfaction. Based on the results from Urban's study, all navigators experienced satisfaction problems in the areas of autonomy, growth satisfaction, job security, and pay satisfaction. Urban recommended job redesign for the navigators who perform the tanker and strategic airlift mission (50:100). However, because regulations and procedures restrict the operational tasks of military aircrew members, Urban recognized that opportunities for navigator job redesign are limited.

A significantly lower mean than the normative data in Autonomy was the only common measurement between Urban's navigator study and the pilots surveyed in this analysis.

The pilots' responses for Skill Variety and the motivating potential score (MPS) were significantly lower than the norms also. The low MPS measurement from pilots would indicate job redesign may be needed for all navigators. However, Urban's study of navigator responses found significantly lower MPS measurements only among the tanker and strategic airlift missions.

Because of the small sample sizes of subcategories, the need for a redesign of navigator job responsibilities in only certain aircraft missions is inconclusive. Qualitative analysis of the comments that accompanied over sixty percent of the pilot responses may support Urban's conclusion that redesign was not needed for fighter, tactical airlift, and strategic bomber navigators:

An F-1F Fiot, major, 31-35 years old with 2600 total hours, 31o in the F-4, and navigator supervisory experience (MPS = 109.0, CPS = 71.1) stated,

> The F-15E mission (night low level weapons delivery) requires a well-trained WSO to accomplish the task. It also requires a well-trained pilot.

A C-130E Aircraft Commander, captain, 26-30 years old with 1600 total hours and supervisory experience (MPS = 244.9, CPS = 266.0) pointed out,

> Qualified navigators are an integral and absolute must on our aircraft. We could not possibly accomplish any of our missions without them. Taking the nav out of the C-17 was an error. I've had my tail saved more than once by a nav and I think they are an absolute necessity in the low-level environment no matter how complex our computer <u>backups</u> become.

A B-52H Aircraft Commander, captain, 26-30 years old with 1500 total hours and navigator supervisory experience (MPS = 80.6, CPS = 163.3) argued,

> Navigators are essential in completing the mission of strategic bombers. Real world missions can be longer than 15 hours. A reduction in the workload is a must to complete long duration sorties. If you want or need real data, examine the F-111 raid on Tripoli in 1986.

However, some differences were noted among pilot comments from all aircraft categories. From the comments presented below and in Chapter IV, some pilots from various aircraft seem divided as to whether the navigator is needed:

A C-130E Aircraft Commander, captain, 26-30 years old with 1200 total hours and navigator supervisory experience (MPS = 44.0, CPS = 17.8) said,

> Question #6 in part III is crucial. Navigators in the future are only necessary or useful for low level missions to supplement the electronic gear. And this is the case only when the nav equipment errs or is not functional. Navs should not be needed for the C-17.

A KC-135A Assistant Chief Mission Development, captain, 31-35 years old with 1850 total flight hours and navigator supervisory experience (MPS = 75.1, CPS = 46.7) stated,

> There is a strong need for WSOs in aircraft such as the B-52, F-111, F-15E. But, I do not believe that it is a needed crew position on other mission aircraft such as the KC-135. With inertial and doppler--and the incoming GPS--the pilot team will be able to assume any duties of the navigator.

Unfortunately, larger stratified samples are required to accurately identify mission-specific needs for navigator job redesign. This study did support the navigator's perception of the need for redesign in the area of autonomy.

One of Urban's recommendations for improving navigator autonomy was pursued as the second portion of the analysis plan for this study.

Supervisor/Observer Job Profiles. Dividing the pilots into categories defined by military rank and supervisor experience was accomplished to analyze the second research objective. The use of Hackman and Oldham's job profile attempted to identify similar "shapes" of the five core job dimensions in the comparisons of navigator, supervisor, and observer perceptions.

The job profile comparisons apparently indicate that additional analysis is required before job redesign is initiated. It is important to realize that separating the pilots into supervisory and non-supervisory categories does not necessarily meet Hackman and Oldham's criteria of supervisor and outside observer. JRF responses from other aircraft crewmembers, such as flight engineers, boom operators, or tail-gunners, may have provided the differentiation Hackman and Oldham predicted. The dependence of each crewmember on others in the aircraft to successfully complete the mission also tends to obscure the normal differences exhibited between workers, their supervisors, and outside observers.

The Second Stage of the Analysis Plan

The second stage of this study's analysis plan addressed the third research objective and sought to

evaluate the pilot's perception of the potential for senior, more experienced navigators to assume the mission commander responsibility instead of the aircraft commander. A Command Potential Model for evaluating the pilot's perception of this construct was introduced in Chapter II which provided the diagnostic tool for this portion of the analysis plan.

Regardless of the apparent suitability of the CPS model, no significant differences were found between the CPS values for any of the pilot categories. This lack of a significant difference between categories is not surprising when compared to the similar lack of differentiation exhibited by the MPS values. This apparent homogeneity among the pilot categories may not support the earlier conclusion that navigator job characteristics must be evaluated by aircraft mission to identify potential differences. However, stratifying the responses by aircraft mission may identify differences in the pilots' perception of navigator command potential in the same way different pilot perceptions of job satisfaction are identified.

Section Three Questions Eight and Nine. Comparisons of the questions eight and nine responses in Section Three did not indicate significant differences between pilot categories. However, the most significant result of the study seemed to be the profound difference between the mean values for questions eight and nine within each category. Of the fourteen separate categories analyzed in Chapter IV,

all exhibited significant differences between the responses to these particular questions. Because of this obvious difference between these two questions, a two "viewpoint" approach to the third investigative question was considered.

The high mean values for question eight responses in all categories, except the fighters, indicate a high perceived need and value of navigators by Air Force pilots. Comments, such as the following, reinforce these quantitative analyses:

A C-130E Pilot, 1Lt, 26-30 years old with 789 total hours and no supervisory experience (MPS = 77.7, CPS = 281.5) stated,

> I feel that with new and improved navigational systems being incorporated into the aircraft, the role of the navigator has been diminished and is almost redundant. But, as we all know, fancy electronic equipment has a tendency to fail at crucial times in flight. The most important thing the nav does on a C-130 is back up the pilots. The nav provides an extra set of eyes, ears, and hands when the pilots become task saturated.

A B-52 Aircraft Commander, captain, 26-30 years old with 1560 total hours and navigator supervisory experience (MPS = 61.3, CPS = 161.2) argued,

> GPS and advanced INS are great--when they work. For training missions where we see the same low levels time and again, we can probably get by, but training missions are different than wartime missions. If you're serious about having a creditable wartime capability, a navigator is a must.

A C-130 Research Test Pilot, major, over 40 with 4800 total hours in various aircraft and navigator supervisory experience (MPS = 87.6, CPS = 144.0) agreed,

> There is still a need for the nav/WSO as a backup/ co-partner in the analysis and operation of complex state of the art equipment. Pilot saturation is and will be our next biggest problem.

The significantly lower response means for question nine reflect a strong resistance for pilots to relinquish the authority for making mission-related decisions. Part of a pilot's reluctance in sharing command responsibility may be because it is difficult to separate mission-related decisions from the decisions which must be made by the aircraft commander. As indicated in the following comment, the differentiation between an aircraft commander and a mission commander is not always clear:

A B-52 Copilot, 1Lt, under 26 with 375 total hours and no supervisory experience (MPS = 221.2, CPS = 134.8) stated,

> In my short experience in multi-place aircraft, I have already found the navigator crew position to be one of tremendous importance and responsibility. The navigator is invaluable in the B-52. Current thought, however, on the "mission commander" position is misguided if it leads to anyone other than the <u>aircraft</u> commander becoming the <u>mission</u> commander.

The difference between mission and aircraft commander responsibilities is not always easily defined. In some aircraft the differentiation may be more difficult than in others. The majority of the comments against the designation of a separate mission commander were from the less experienced pilots who may not have flown long enough to recognize that in some aircraft there can be two areas of command responsibility. However, with an overall response

mean of 2.65 for question nine, obviously some responses had to be above the low, "inaccurate" end of the scale.

A total of 16 of the 93 pilots responded with a five, six, or seven ("slightly, mostly, or highly accurate") response to question nine. Eleven of these 16 "accurate" responses were from tactical airlift or strategic bomber pilots. Eleven pilots out of the total of 93 responded with a four, or "uncertain" answer. Therefore, 66 or 71 percent of the respondents answered with an "inaccurate" (one, two, or three) response. The tanker and strategic airlift categories accounted for 46 of the 66 "inaccurate" responses for question nine.

From the above analysis, one significant conclusion to be made from the question eight and nine responses is that there is no "stereotypical" answer among Air Force pilots concerning navigator mission command potential. Intuitively, one might have expected all pilots to respond with a one, two, or three answer for question nine. Perhaps the aircraft missions that have the strongest need for the navigator are flown by pilots who recognize that experienced navigators have as much ability as they to make mission-specific decisions. The results seem to support that conclusion as much as the conclusion that aircraft missions that do not require a navigator are flown by pilots who obviously have little knowledge of what a navigator's abilities might include.

In the author's experience, few navigators are satisfied flying on an aircraft where their abilities are not needed. The most satisfying flight experience for most navigators is flying with pilots who could not have done the mission without them. The fact that the Air Force has and will continue to have aircraft missions that must have the navigator's expertise to successfully complete the mission is justification to evaluate the advantages of sharing the command responsibility with senior, more experienced navigators.

Again, in the author's experience, some aircraft commanders have welcomed the opportunity to separate some of the mission responsibilities from more critical "safety of flight" responsibilities. Task saturation was mentioned in several of the comments from the pilots' responses. In some ways, mission tasks can compound the problem of task saturation. "War stories" of flying an unsafe aircraft to complete the mission should be reserved for wartime flight environments. Granting a senior navigator the authority to make mission-related decisions may not prevent pilots from flying unsafe aircraft but, as the overwhelming "accurate" responses to question eight indicate, it may help the pilot to maintain the correct "safety of flight" priorities.

Conclusions on Navigator Requirements

Although the navigator requirement for the strategic airlift and, possibly, the air refueling missions may be

questioned by many pilots, many of the respondents in this study also questioned the decision against using navigators in the C-17 and B-2 aircraft:

A T-43 Aircraft Commander, captain, 31-35 with 4650 total hours, 2700 in the C-130, and navigator supervisory experience (MPS = 145.2, CPS = 191.4) argued,

> Unless you have triple redundant INS or at least two complete GPS systems, you'll always need the navs on most missions, especially older aircraft like the C-130 that do not have INS or GPS. I feel the pilots (in the C-17) will be task saturated very easily trying to fly, airdrop, and run systems at the same time. The C-17 needs a nav.

A B-1B Instructor Pilot, major, 31-35 years old, 3200 total hours, 1900 hours in the B-52, and navigator supervisory experience (MPS = 213.9, CPS = 151.1) added,

> As in any career field there are good navigators and bad navigators. I personally feel it would be easier to teach a navigator how to refuel, recover, and land an aircraft like the B-2 than it would be to teach a pilot the art of navigation. What we need is more highly skilled navigators and fewer systems operators. Take a look at the early days of the F-4 program with two pilots on board. Learn from history or we are destined to make the same mistakes.

A B-52H Pilot, captain, 26-30 years old with 1300 total hours and no supervisory experience (MPS = 76.4, CPS = 103.9) stated,

> I feel that by removing the navigator position from the B-2, much of the flexibility and potential for other type missions for the aircraft have also been removed.

Several comments recalled the previous, unsuccessful Air Force efforts to fly two pilot crews in the F-4 and

F-111 aircraft. The fact that the B-2 was designed for a pilot/WSO crew complement has merely added to the confusion caused by the announcement that the aircraft will have a two pilot crew with the right-seat pilot performing the duties of a navigator/WSO and mission commander (1:26). The question this issue raises is: Why delete the requirement for a crewmember who has been trained to perform the mission and who represents the career field with the highest retention rate in the Air Force, and replace that individual with a crewmember who will need additional training to perform the mission and who represents a career field with one of the lowest retention rates?

Future Navigator Requirements. The number of positions requiring navigators in the future will decrease at the same or faster rate as the requirements for every Air Force career field. The overall size of the military is forecast to drop significantly in the next five years. Because most computer navigation systems now have both increased accuracy and reliability, navigator requirements will probably decline faster than those of other military career fields.

However, the need for navigators will not disappear completely as long as the Air Force has outdated aircraft that have a mission to perform. Budget limitations will probably keep outdated aircraft in the inventory well into the next century. One important question that must be answered is, will the Air Force be able to keep the

navigators it needs in the career field regardless of the low morale that a dying career field may create?

The Air Force mission has been successfully performed for many years without necessarily recognizing the senior rated officer on the crew as the mission commander. The Air Force alone has had this requirement, contrary to the fact that the U.S. Navy and many of the NATO air forces recognize the senior officer as the mission commander. In reality, many Air Force missions are flown today with an aircraft commander who does not make the decisions on how the aircraft will best complete the mission. Mission-related decisions concerning how best to employ the aircraft in some cases are made by navigators, non-rated officer crewmembers, and even senior non-commissioned officers. On airborne warning and control (AWACS), strategic reconnaissance, and Advanced Range Instrumentation Aircraft (ARIA) test and evaluation missions, for example, the aircraft commander does not always make the mission-related decisions. Because of the complexity of some Air Force missions, not only the aircraft commander but also the command authority realizes that other crewmembers sometimes have more experience and information available with which to make better decisions. The difference is that these "non-pilot" mission commanders are not given formal authority to act as the mission commander, although the responsibility for the decisions has been delegated to them.

On missions in which the navigator has the experience and responsibility to act as the mission commander, formal authority as the mission commander could improve the autonomy of the job, improve the satisfaction associated with that job, improve the morale of those who aspire to remain in the career field, and improve their job security and promotion potential. Serving as mission commanders may be the only opportunity for navigators to gain command experience at a time in their career when officers in every other career field are able to gain command experience.

An Alternate Career Opportunity

As the requirement for navigators decreases with the advancement of navigational systems technology, many non-flying career opportunities may continue to be available for navigators. Unfortunately, as the military personnel requirement also decreases, navigators will have to compete for the non-flying assignments along with the non-rated officers. One career field where navigators routinely do well, but their opportunity for selection has not increased significantly, is that of pilot training. One of the pilots commented on this fact.

A KC-135 Aircraft Commander, captain, 26-30 years old with 1900 total flight hours and navigator supervisory experience (MPS = 91.5, CPS = 63.3) observed,

> If the KC-135 was configured like a KC-10, i.e. flight engineer and better navigation equipment, the role of the navigator would be eliminated. I feel the Air Force should open up more slots in UPT for navigators.

Their flying experience will give them a better grasp at gaining the situational awareness required for a pilot.

Currently, only about fifty navigators are selected for undergraduate pilot training each year, yet they have the lowest "wash-out" rate of all pilot trainees. The reasons given in the past for not increasing the number of pilot training positions for navigators was the lack of total training positions available and the continuing need for navigators. Both of these reasons may disappear in the near future. If the accession of new second lieutenants is decreased due to manning reductions, more of the total pilot training positions should be available to navigators. If navigator requirements decrease due to advanced technology, more navigators should be available to compete for pilot training. The major limitation for many navigators in the selection for pilot training is eyesight. Yet perfect eyesight is not a requirement for pilots after they complete pilot training. Waivers have been granted in the past for eyesight restrictions. Vision waivers should be reconsidered for navigators because they are retainable and have a successful pilot training completion rate.

Recommendations for Further Study

The recommendations for additional study in this area follow two paths. First, the continued requirement for the navigator/WSO in tactical airlift and specific fighter missions appears to be obvious to both pilots and

navigators. The strategic airlift mission may no longer require the navigator expertise. However, the tanker and strategic bomber navigator requirement needs additional study among navigators as well as pilots. If valid results are to be obtained concerning job redesign by aircraft mission, random samples sufficient to gain the 90 percent level of confidence within the aircraft mission category are required.

Stratified samples of tanker and strategic bomber pilots and navigators would require approximately sixty responses per aircraft crew position to obtain results that could be generalizable to the entire career field. The observer responses to the JRF could be strengthened by surveying the boom operators in the tanker and the B-52 tail-gunners.

The usefulness of the Command Potential Model cannot be determined without additional testing. Additional modifications to the CPS formula, or the attributes which define it, may be necessary. Additions or deletions to the Section Three questions may be required. A modified CPS instrument could be developed for navigators and administered to them, along with the JDI instrument suggested by Hackman and Oldham, to strengthen the results of the analysis.

The second recommendation area for additional study pertains to Hackman and Oldham's "multiple-method" approach (19:102). Interviews with pilots, navigators, squadron

commanders, wing commanders, and headquarters staff may be used to reinforce or refute the conclusions that have been made by this study and previous efforts. Interviews or mail surveys could also be conducted with U.S. Navy aviators or members of the NATO forces to compare job satisfaction and command potential opportunities among their navigator-equivalent officers.

Summary

This chapter has brought this research effort to a logical conclusion. Additional limitations of the analysis were reviewed along with limitations of the sampling plan. Conclusions based on the evaluation of the research objectives were provided for the two stages of the analysis plan. Conclusions and recommendations for future navigator requirements were discussed along with recommendations for further study. Qualitative comments, such as the following, were provided throughout to add credibility to the quantitative comparisons.

A B-1B Aircraft Commander, captain, 26-30 years old with 2200 total hours and navigator supervisory experience (MPS = 248.6, CPS = 214.1) recognized,

> In general, a navigator, competent in his duties, with a positive attitude is vital to the mission and worth his weight in gold. It's a shame that pilots are given greater opportunities for command and promotion in my career field. This is the cornerstone for animosity and my hat is off to the majority of navs that accept this fate and continue to do their jobs in a professional manner.

Appendix A. Survey Questionnaire

USAF Survey Control No. 90-50
Expiration Date: 1 Aug 90

USAF PILOT SURVEY OF NAVIGATOR JOB CHARACTERISTICS

BIOGRAPHICAL DATA

1. What is your current Air Force Specialty Code (AFSC) and Duty Title? ____________________

2. What is your current rank?

    ____ A. 2 Lt

    ____ B. 1 Lt

    ____ C. Capt

    ____ D. Maj

    ____ E. Lt Col

3. What is your age?

    ____ A. under 26

    ____ B. 26 - 30

    ____ C. 31 - 35

    ____ D. 36 - 40

    ____ E. over 40

4. To what aircraft are you currently assigned? __________

5. What are your current total flying hours? __________

6. From the list below, indicate the number of flying hours of any additional aircraft (excluding T-37/T-38) in which you have had flying experience. (If applicable, indicate navigator flying hours with an "N" prefix; for example, 500 navigator hours of 1200 total hours in the B-52 would be indicated as N500/1200):

A. B-52 ____________ hours

B. C-130 ____________ hours

C. C-141 ____________ hours

D. F/RF-4 ____________ hours

E. F/EF/FB-111 ____________ hours

F. C/EC/KC/RC-135 ____________ hours

G. Others (indicate only aircraft with navigator crew position) ______ ________________ hours
______ ________________ hours

7. What is your sex?

____ A. Male

____ B. Female

8. How long have you held your current position?

_____ year(s) _____ month(s)

9. In your current position, how many others do you supervise?

____ A. None

____ B. 1-2

____ C. 3-5

____ D. 6-10

____ E. more than 10

10. Do you now supervise or have you ever supervised one or more navigators?

____ A. Yes ____ B. No

JOB RATING FORM

The following questions in Sections One and Two were developed as part of a Yale University study of jobs and how people react to them. The questions help to determine how jobs can be better designed by obtaining information about how people react to different kinds of jobs.

You are being asked to rate the job characteristics of the

U.S. Air Force navigator/weapon systems officer (WSO). Please keep in mind that the following questions refer to the job of the navigator/WSO, and not to your own job.

On the following pages, you will find several different types of questions about the job of the navigator/WSO. Specific instructions are given at the start of each section. Please read them carefully. It should not require more than 15 minutes to complete all the questions. Please complete each section as quickly as possible.

SECTION ONE

This part of the questionnaire asks you to objectively describe the job of the navigator/WSO. Try to make your description as accurate and objective as you possibly can.

A sample question is given below.

A. To what extent does the job require a person to work with mechanical equipment?

1--------2--------3--------4--------5--------6--------7

Very little; the job requires almost no contact with mechanical equipment of any kind.	Moderately	Very much; the job requires almost constant work with mechanical equipment.

You are to circle the number which is the most accurate description of the job. A specific number must be circled.

If, for example, the job requires a person to work with mechanical equipment a good deal of the time--but also requires some paperwork--you might circle the number six, as was done in the example above.

Please turn the page and continue.

1. To what extent does the job require a person to <u>work closely with other people</u> (either clients, or people in related jobs in your own organization)?

1--------2--------3--------4--------5--------6--------7

Very little; dealing with other people is not at all necessary in doing the job.	Moderately; some dealing with others is necessary.	Very much; dealing with other people is an absolutely essential and crucial part of the job.

2. How much <u>autonomy</u> is there in the job? That is, to what extent does the job permit a person to decide on <u>his or her</u> own how to go about doing the work?

1--------2--------3--------4--------5--------6--------7

Very little; the job gives a person almost no personal "say" about how and when the work is done.	Moderate autonomy; many things are standardized and not under the control of the person, but he or she can make some decisions about the work.	Very much; the job gives the person almost complete responsibility for deciding how and when the work is done.

3. To what extent does the job involve doing a <u>"whole" and identifiable piece of work</u>? That is, is the job a complete piece of work that has an obvious beginning and end? Or is it only a small <u>part</u> of the overall piece of work, which is finished by other people or by automatic machines?

1--------2--------3--------4--------5--------6--------7

The job is only a tiny part of the overall piece of work; the results of the person's activities cannot be seen in the final product.	The job is a moderate-sized "chunk" of the overall piece of work; the person's own contribution can be seen in the final outcome.	The job involves doing the whole piece of work, from start to finish; the results of the person's activities are easily seen in the final product.

4. How much variety is there in the job? That is, to what extent does the job require a person to do many different things at work, using a variety of skills and talents?

1--------2--------3--------4--------5--------6--------7

Very little; the job requires a person to do the same things over and over again.	Moderate variety.	Very much; the job requires a person to do many different things, using a number of different skills and talents.

5. In general, how significant or important is the job? That is, are the results of the work likely to significantly affect the lives or well-being of other people?

1--------2--------3--------4--------5--------6--------7

Not very significant; the outcomes of the work are not likely to have important effects on other people.	Moderately significant.	Highly significant; the outcomes of the work can affect other people in very important ways.

6. To what extent do managers or co-workers let a person know how well he or she is doing on the job?

1--------2--------3--------4--------5--------6--------7

Very little; people almost never let the person know how well he or she is doing.	Moderately; sometimes people may give the person "feedback"; other times they may not.	Very much; managers or co-workers provide the person with constant "feedback" about how well he or she is doing.

7. To what extent does doing the job itself provide a person with information about the work performance? That is, does the actual work itself provide clues about how well a person is doing--aside from any "feedback" co-workers or supervisors may provide?

1--------2--------3--------4--------5--------6--------7

Very little; the job itself is set up so a person could work forever without finding out how well he or she is doing.	Moderately; sometimes doing the job provides "feedback" to the person; sometimes it does not.	Very much; the job is set up so that a person gets almost constant "feedback" as he or she works about how well he or she is doing.

SECTION TWO

Listed below are a number of statements which could be used to describe a job.

You are to indicate the degree to which each statement is an accurate or inaccurate description of the job of the

U.S. Air Force navigator/weapon systems officer (WSO).

Once again, please try to be as objective as you can in deciding how accurately each statement describes the job--regardless of your own feelings about that job.

Write a number in the blank beside each statement, based on the following scale of accuracy:

1	2	3	4	5	6	7
Very	Mostly	Slightly	Uncertain	Slightly	Mostly	Very
¦<-----INACCURATE------>¦				¦<------ACCURATE----->¦		

How accurate is each statement below in describing the job of the United States Air Force navigator/weapon systems officer (WSO)?

_____ 1. The job requires a person to use a number of complex or high level skills.

_____ 2. The job requires a great deal of cooperative work with other people.

_____ 3. The job is arranged so that a person does not have the chance to do an entire piece of work from beginning to end.

_____ 4. Just doing the work required by the job provides many chances for a person to figure out how well he or she is doing.

_____ 5. The job is quite simple and repetitive.

_____ 6. The job can be done adequately by a person working alone without talking or checking with other people.

_____ 7. The supervisors and co-workers on this job almost never give a person any "feedback" about how well he or she is doing the work.

_____ 8. This job is one in which many other people can be affected by how well the work gets done.

_____ 9. The job denies a person any chance to use his or her personal initiative or judgment in carrying out the work.

_____ 10. Supervisors often let the person know how well they think he or she is performing the job.

_____ 11. The job provides a person the chance to completely finish the pieces of work he or she starts.

_____ 12. The job itself provides very few clues about whether or not the person is performing well.

_____ 13. The job gives a person considerable opportunity for independence and freedom in how he or she does the work.

_____ 14. The job itself is not very significant or important in the broader scheme of things.

SECTION THREE

Using the same scale as was used in Section Two, write a number beside each statement below indicating whether, based on your experience, it is an accurate or inaccurate statement.

All information will be held in the strictest confidence; no one in your organization will have access to individual responses.

Write a number in the blank beside each statement, based on the following scale of accuracy:

1	2	3	4	5	6	7
Very	Mostly	Slightly	Uncertain	Slightly	Mostly	Very
¦<----INACCURATE-- -->¦				¦<-----ACCURATE----->¦		

_____ 1. The increasing complexity of operating advanced weapon systems, such as the F-15E, indicates the need to retain the expertise of the navigator/WSO in advanced fighter aircraft.

_____ 2. The Global Positioning Satellite (GPS) system and improved inertial navigation systems have replaced the requirement for the navigator/WSO in military aircraft.

_____ 3. Pilots can become task-saturated by the many activities associated with take-off, departure, and approach to landing, low-level flight, and inflight emergencies. The additional set of eyes and ears of the navigator/WSO is critical to mission success and flight safety.

_____ 4. Although the aircraft commander is ultimately responsible for "safety of flight" decisions, he or she often relies on the navigator/WSO, if available, for assistance in making mission-related decisions.

_____ 5. An experienced navigator/WSO is better qualified to make mission-related decisions than a less-experienced pilot.

_____ 6. The expertise of the navigator/WSO is needed only on designated missions, such as airdrop and low-level, where the normal positioning errors of inertial navigational equipment could critically affect mission success or flight safety.

____ 7. The navigator/WSO crew position should have been included on recently developed aircraft, such as the C-17 and B-2.

____ 8. An experienced navigator/WSO who makes mission-related decisions will better enable the pilot to make correct decisions concerning flight safety issues.

____ 9. On multi-place aircraft, the senior rated officer (assuming equal or greater flight experience) should be designated as mission commander, even if it is the navigator/WSO, as long as his or her duties do not conflict with those of the aircraft commander.

Please feel free to comment on any aspect of the navigator/WSO career field (positive or negative). Your responses here are extremely critical in addressing current issues concerning navigators.

If additional space is needed, please feel free to use a separate sheet of paper.

Appendix B. Section Three Pretest Questions

Using the same scale as was used in Section Two, write a number beside each statement below indicating whether, based on your experience, it is an accurate or inaccurate statement.

____ 1. The increasing complexity of operating advanced weapon systems, such as the F-15E, indicates the need to retain the expertise of the navigator/WSO in advanced fighter aircraft.

____ 2. The expertise of the navigator/WSO is needed only on designated missions where the normal positioning errors of inertial navigational equipment could be catastrophic.

____ 3. The navigator/WSO crew position should have been included on critically expensive aircraft, such as the C-17 and B-2.

____ 4. The Global Positioning Satellite (GPS) system and improved inertial navigation systems have replaced the requirement for the navigator/WSO in military aircraft; the career field should be closed.

____ 5. Pilots can become task-saturated by the many activities associated with take-off, departure, and approach to landing, low-level flight, and inflight emergencies. The additional set of eyes and ears of the navigator/WSO is invaluable.

____ 6. Although the aircraft commander is ultimately responsible for "safety of flight" decisions, he or she must rely on other crewmembers, if available, for assistance in making mission-related decisions.

____ 7. A more experienced navigator/WSO can make better mission-related decisions than a less experienced pilot.

____ 8. A pilot could make better decisions concerning "safety of flight" issues if he or she were not also responsible for mission-related decisions.

____ 9. The senior rated officer (even if it is the navigator/WSO) should be designated as mission commander on multi-place aircraft with duties that will not conflict with those of the aircraft commander.

Appendix C. Survey Questionnaire Scoring Key

I. JOB CHARACTERISTICS

A. Skill variety. Average the following items:

Section One: #4
Section Two: #1
#5 (reversed scoring; i.e., subtract the number entered from 8)

B. Task identity. Average the following items:

Section One: #3
Section Two: #11
#3 (reversed scoring)

C. Task significance. Average the following items:

Section One: #5
Section Two: #8
#14 (reversed scoring)

D. Autonomy. Average the following items:

Section One: #2
Section Two: #13
#9 (reversed scoring)

E. Feedback from the job. Average the following items:

Section One: #7
Section Two: #4
#12 (reversed scoring)

F. Feedback from agents. Average the following items:

Section One: #6
Section Two: #10
#7 (reversed scoring)

G. Dealing with others. Average the following items:

Section One: #1
Section Two: #2
#6 (reversed scoring)

II. MOTIVATING POTENTIAL SCORE (MPS)

$$\text{MPS} = \frac{\text{Skill variety} + \text{Task identity} + \text{Task significance}}{3} \times \text{Autonomy} \times \text{Job feedback}$$

III. COMMAND POTENTIAL ATTRIBUTES
(not applicable for pretest questions)

A. Retain. Average the following items

Section Three: #1
Section Three: #2 (reverse scoring)
Section Three: #7

B. Value

Section Three: #3
Section Three: #6 (reverse scoring)
Section Three: #9

C. Mission

Section Three: #4
Section Three: #5
Section Three: #8

IV. COMMAND POTENTIAL SCORE (CPS)

CPS = Retain X Value X Mission

Appendix D. Description of the Statistical Analysis

Various statistical tests were available to analyze the degree of association exhibited by the correlational data obtained from this research. Comparison of means, analysis of variance, and correlation analysis were chosen as the preferred statistical tests for the survey data.

The t-distribution was used for all the means comparisons in this study because of its versatility for use with small samples ($n < 30$) and large samples ($n > 30$). According to Kachigan, the primary difference in the t-distribution and the normal z-distribution, used with samples greater than thirty, is in the method of calculating the confidence intervals for hypothesis testing (24:144). With large sample sizes, the z-statistic for calculating the confidence interval uses the sample standard deviation to approximate the population standard deviation. Based on the Central Limit Theorem, the sample standard deviation for a small sample size cannot be assumed to approximate a normal distribution. Therefore, the degrees of freedom (df) characteristic, where $df = n - 1$, associated with each sample size of n, is used to compute a t-statistic for determining an exact confidence interval (24:145). For smaller sample sizes, the t-distribution yields a wider confidence interval to accommodate the potential for more variability in the sample means. As the sample size

increases, the confidence interval decreases to a point at which the t-distribution for n greater than thirty is a good approximation of the normal distribution.

The null hypothesis for all comparisons in this study stated that the means were equal. Because the alternate hypothesis assumed the means were not equal, two-tailed t-tests were performed. Use of the t-test requires that the following assumptions be made:

> 1. The samples are independent. That is the selection of any one case should not affect the chances for any other case to be included in the sample.
>
> 2. The samples should be drawn from normally distributed populations.
>
> 3. The populations should have equal variances.
>
> 4. The measurement scales should be at least interval so that arithmetic operations can be used with them. (11:358)

Although the Likert scale of measurement is considered as ordinal-level data, the comparison of means is required in the use of the scoring key of the JRF survey instrument. The comparison of means analysis was used for hypothesis testing in both Urban's and Dotson and Hilbun's earlier studies (50:49). According to Emory, use of the mean as the measure of central tendency may "be used with ordinal data when they seem to approach interval scales in nature" (11:90). The underlying assumptions for the t-test stated above are not that inflexible because they "hold up well even though actual conditions depart substantially from

those theoretically required" (11:358). Kachigan also points out:

> The t-test has been shown through extensive computer simulation work to be very robust, in the sense that violations of normality and equality of variance do not greatly affect the accuracy of the probability statements resulting from the tests . . . . In short, while violated assumptions of the t-test reduce its power, it is still more powerful than the alternative nonparametric tests in the vast majority of situations encountered in the world at large. (24:461)

Problems which may arise when assumptions of normality and equality of variance are violated can be compensated for by using more conservative significance levels in the testing of the null hypotheses (24:461). For this research analysis the alpha value, or probability of rejecting the null hypothesis when it should be accepted is .05; or, in terms of the confidence that a true null hypothesis will be accepted, the confidence level is 95 percent (11:353). Urban used an alpha value of .10 in his study, apparently "to reflect the 90% confidence level established by the sample size" (50:50). However, the lower confidence level of the sampling plan does not necessarily influence the rejection region of the hypothesis testing. Based on the previous discussion of the robustness of the t-test, a more conservative alpha value for the hypothesis tests seems to be warranted in this case.

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS-X) available through the AFIT Computer Services Division (AFIT/SC) and two personal computer software programs,

MathCAD and Statistix II. First, the FREQUENCIES subprogram of SPSS-X was used to examine the survey responses by variables (41:316). From these data, demographics of the respondents and response rates by rank could be determined. Sample means and standard deviations of each variable were provided as an optional statistic with this subprogram. The CROSSTABS subprogram was then used to rearrange the response data into tabular categories representing the various aircraft by rank and navigator supervisory experience of the respondents (41:338). Numbers of responses representing each aircraft category could also be determined.

Comparison of Means

For analyzing the first investigative question, a template was developed from the Borlund International software, MathCAD (44), which compared the sample means for each of the job dimensions and MPS in this study to the JDS normative data provided by Hackman and Oldham (19:313). The same norms for "technical or professional" workers were used in this study as were used in Urban's research (50:43). The means of the professional workers were defined as the population means (μ) in the first equation of the MathCAD template which is illustrated in Appendix D. The second formula presented in Appendix D was used to perform two-sample t-tests when comparing the results from this study to the navigator means in Urban's research. By changing the known values in both of the equations in the MathCAD

template, the T values were obtained for each set of means that were compared.

After obtaining the appropriate T value from the MathCAD computations, the "probability distributions" subprogram in the Statistix II software was used to obtain the P value for a two-tailed t-test with each specific degrees of freedom. The degrees of freedom for these analyses were either the number in the sample minus one (n - 1) for the one-sample t-test, or the sum of the number in both samples minus two (n + np - 2) for the two-sample t-test. Based on the P value obtained from the Statistix II computation, the null hypothesis, that the means were statistically the same, was accepted if the P value was equal or greater than an alpha of .05 or rejected, and the means were considered statistically not equal, if the P value was less than the .05 alpha value.

Analysis of Variance

The analysis of variance (ANOVA) technique was used to test the significance of groups of sample data, such as comparisons by rank of the respondents. According to Kachigan, ANOVA encompasses many "techniques for identifying and measuring the various sources of variation within a class of data" (24:273).

The significance of the differences in the means is determined by breaking down the total variance of the data into the "component sources which can be attributed to

various factors in the research" (11:369). The F-test is used to compare the sampling (within-groups) variance to the total (between-groups) variance of the sample data. The F-statistic, a ratio of these two portions of the group variance, determines a P value for acceptance or rejection of the null hypothesis based on a chosen alpha value.

The SPSS-X subprogram, ONEWAY, calculated the one-way analyses of variance for the group means of data and Tukey's multiple range test was used to identify means of the job dimensions, MPS, command potential attributes, and CPS variables that were significantly different (41:466).

The T-TEST subprogram of SPSS-X was also used to perform comparisons of means within other variable categories, such as navigator supervisor experience, to evaluate investigative questions two and three.

Reliability and Correlation Analysis

The validity and reliability of the JRF questionnaire has been reported by Hackman and Oldham to be satisfactory (18:19). However, the nine questions added in the third section of the questionnaire required some degree of reliability and internal validity assessment. Emory defines reliability as "estimates of the degree to which a measurement is free of random or unstable error" (11:98). While not as valuable as the assessment of validity, the control of reliability reduces the interference of equivalence in the measurements (11:99).

RELIABILITY is a SPSS-X subprogram which uses several split-half techniques in testing for sample equivalence (22:256). The Spearman-Brown coefficient compares the reliability of the split-halves, assuming each has equal reliability and variability. The Guttman split-half technique is similar to the Spearman-Brown; however, it does not assume the two have equal reliability and variance. This subprogram also tests for internal consistency and homogeneity by computing Cronbach's Coefficient Alpha in which multiple random halves are tested for equivalence (11:100). The reliability of the survey questionnaire is discussed in Chapter IV.

The term correlation can be defined simply as the relationship between two variables (13:67). The SPSS-X subprogram, PEARSON CORR, was used to test for the construct validity of the command potential attributes, measured by the Section Three questions of the questionnaire.

The Pearson product-moment coefficient, r, is a summary statistic which represents the linear relationship between two variables (11:391). The Pearson coefficient can range from a value of +1, a perfect positive correlation, to -1, a perfect inverse correlation. A zero coefficient represents the absence of any correlation.

This type of correlation analysis was also used to determine the degree of association exhibited by the command potential attributes and the job satisfaction dimensions of the JCM.

Appendix E. MathCAD Template for Calculation of Sample Size

Calculation of sample size for 90% confidence level with a + or - 10% interval:

n = sample size N = population size
d = desired tolerance p = maximum sample size factor
z = factor of assurance for 90% confidence level

$d := .1 \qquad p := .5$

$z := 1.645$

For a sample size of applicable pilot population:

$N := 10914$

1. $$n := \frac{N \cdot z^2 \cdot p \cdot (1 - p)}{(N - 1) \cdot d^2 + z^2 \cdot p \cdot (1 - p)}$$

$n = 67$

For a sample size of the first lieutenant subpopulation:

$N := 1966$

2. $$n := \frac{N \cdot z^2 \cdot p \cdot (1 - p)}{(N - 1) \cdot d^2 + z^2 \cdot p \cdot (1 - p)}$$

$n = 65$

For a sample size of the pretest population:

$N := 60$

3. $$n := \frac{N \cdot z^2 \cdot p \cdot (1 - p)}{(N - 1) \cdot d^2 + z^2 \cdot p \cdot (1 - p)}$$

$n = 32$

Appendix F. MathCAD Template for Comparison of Means

μ = the population mean from the JDS Norms of Hackman and Oldham.
xbar = sample means for USAF navigators
xbar2 = sample means for USAF pilots
s1 = sample standard deviation for navigators
s2 = sample standard deviation for pilots
n = number of nav respondents
np = number of pilots respondents

Accompanying data represents computations for the Feedback from Agents job dimension for U.S. Air Force pilots and navs.

Formula 1 used to perform one sample t-test:

$\mu := 4.2 \qquad xbar2 := 5.07 \qquad s2 := 1.08 \qquad np := 93$

$xbar := 4.6 \qquad s1 := 1.42 \qquad n := 74$

1. $$t_{val} := \frac{xbar2 - \mu}{\dfrac{s2}{\sqrt{np}}} \qquad t_{val} = 7.768$$

degrees of freedom equals $np - 1 = 92$

Formula 2 used to perform a t-test of the significance of the difference of two independent means:

2. $$t_{two} := \frac{xbar - xbar2}{\sqrt{\dfrac{(n-1)\cdot s1^2 + (np-1)\cdot s2^2}{n + np - 2}\left[\dfrac{1}{n} + \dfrac{1}{np}\right]}}$$

degrees of freedom equals $n + np - 2 = 165$ $\qquad t_{two} = -2.429$

Appendix G. Selected Survey Comments

The following remarks are a selection of appropriate comments from the survey responses analyzed in this study which were not discussed in Chapters IV or V. The comments are not presented in any particular order except by aircraft mission. Brief biographical sketches are provided along with the MPS and CPS values for quantitative comparisons.

1. C-21A Aircraft Commander, major, over 40 years old with 4600 total hours, 1500 in the C-5, and navigator supervisory experience (MPS = 161.1, CPS = 65.0):

> The expertise of the nav/WSO is an invaluable aid in the real world of combat for air to air (fighters) and airdrop.

2. C-21A Pilot, captain, 26-30 years old with 2500 total hours, 1000 in the C-141, and navigator supervisory experience (MPS = 118.4, CPS = 60.7):

> Nav's are essential, but only on low level type missions. The INS and other technology gives pilots sometimes "more" information than actually needed.

3. C-23A Pilot/Assistant Operations Officer, major, 36-40 years old with 3650 total hours, 3000 in the C-141, and no navigator supervisory experience (MPS = 62.5, CPS = 83.1):

> I have very little experience flying with navigators. I have only flown with navigators on three occasions, one of which was to Antarctica. Without him, it would have been very difficult to complete the mission. However, on all my other missions in a C-141, a navigator was not required or needed.

4. C-141 Instructor Pilot, captain, 31-35 years old with 3000 total hours, 2200 in the C-130, with navigator supervisory experience (MPS = 79.9, CPS = 93.3):

- C-141B "Tactical VFR" flying should include a navigator. It currently does not include a nav.
- Navigators are an invaluable resource in airdrop C-141/C-130.

5. KC-135R Pilot, 1Lt, under 26 years old with 570 total hours and no supervisory experience (MPS = 197.1, CPS = 248.9):

The navigator is a vital part of the tanker. A KC-10 with no navigator and only INSs often has problems running a good rendezvous (air refueling). The extra set of eyes outside, as well as inside increases the safety of flight.

6. KC-135R Aircraft Commander, captain, 26-30 years old with 1300 total flight hours and navigator supervisory experience (MPS = 149.3, CPS = 210.0):

After five years of being involved in KC-135 air refueling operations, I believe that a good experienced navigator is critical to the safe and successful completion of any refueling mission. Improving navigation systems and avionics is important and will allow current/future navigators to do their jobs better. Improved technology, in this case, does not warrant the replacement of navigators.

7. KC-135R Instructor Aircraft Commander, captain, 26-30 years old with 2000 total flight hours and navigator supervisory experience (MPS = 126.4, CPS = 94.8):

I feel that the navigator is a valuable member of the KC-135 crew. I strongly suggest that fighter aircraft can benefit from the extra man.

8. KC-135 Aircraft Commander, captain, 26-30 years old with 1450 total flight hours and navigator supervisory experience (MPS = 136.0, CPS = 108.3):

> Navigators play an important yet not essential role on an aircrew, depending on mission complexity. I feel the navigator is essential for my aircraft's mission; however, if the cockpit arrangement was to be altered, navigational duties could satisfactorily be handled by the pilots. KC-135s benefit from four crewmembers, but this arrangement could take the form of 2 pilots, a boom (operator), and a flight engineer (i.e. KC-10). Aircraft commanders should always be pilots and always make the decisions affecting the mission.

9. KC-135 Copilot, captain, 26-30 years old with 850 total flight hours and no supervisory experience (MPS =114.7, CPS = 55.6):

> I feel that the term "navigator" should be incorporated into "aviation officer." Today the navigators primary job of navigating can be better handled by technology. However, there are many functions involved in a mission that could be picked up by the aviation officer (i.e. flight engineer duties, WSO duties, and other specialty items particular to the airframe). The extra body in the jet makes a difference. However, one point bothers me from this survey is that several questions concerning decisions made by the navigator in his piece of the pie, he is the only one who knows his job and he can do it anyway he wants to. But, his part of the job is just a part. The pilot is the only one on the aircraft who has the total picture and delegates the tasks to the crew to accomplish the mission. This is the fundamental rule that the aircraft commander is the senior pilot. However, the role of the navigator serves a very integral part of the crew and needs to remain.

10. KC-10 Copilot, captain, 26-30 years old with 1200 total flight hours and 996 in the KC-135, no navigator supervisory experience (MPS = 95.93, CPS = 139.3):

All my responses refer to navigators only. I have no experience with WSOs. However, I strongly feel a third person in a heavy or two in a fighter is critical in times of conflict.

11. KC-135R Aircraft Commander, major, 36-40 years old with 2453.5 total flight hours and navigator supervisory experience (MPS = 94.8, CPS = 11.67):

I have nothing against navs--but the hard truth is that technology--INS in particular, is making their role unnecessary. The airliners don't have them anymore, and the entire Air Force should develop a plan to phase out that career field. A second set of eyes on an F-15E is nice--train a copilot to work the back seat equipment and now you have the safety-of-flight redundancy of two pilots.

12. B-52G Aircraft Commander, major, 36-40 years old with 2,050 total hours and navigator supervisory experience (MPS = 157.4, CPS = 149.3):

Bombers (even the B-2), flying the aircraft and making decisions on target acquisition, aircraft defense, battle damage, and normal systems monitoring could easily overwhelm a two man crew. The C-17 could do with an extra crewmember for mission specifics, airdrops, and low level ingress and egress on or near the forward edge of battle. Special ops definitely need the navigator/WSO crewmember; night ops, pinpoint special forces drops, all need the extra expertise of the trained navigator/WSO.

13. A B-52 Copilot, 1Lt, under 26 with 600 total hours and no supervisory experience (MPS = 183.9, CPS = 158.3):

With the advanced weapon systems today and the complexity of military missions the truth that "two are better than one" is all the more important.

14. F-15E Instructor Pilot, major, 36-40 years old with 2900 total hours, 2500 in the F-4, and navigator supervisory experience (MPS = 154.5, CPS = 204.0):

> The advantage of a WSO in the F-15E is
> 1) extra set of eyes to "check 6" for enemy aircraft/SAMs/etc.
> 2) perform radar search/sort when pilot is flying night LANTIRN.
> 3) upgrading new pilots--instructor WSOs <u>know</u> what a good pilot does.

Quantitative data from the remaining responses were not used due to lack of navigator flight experience by the pilots.

15. F-16C Block 40 Electronic Combat Pilot, captain, under 26 years old with 790 total hours and no navigator supervisory experience:

> With the LANTIRN system becoming operational, the need for increased attention to safety of flight dictates the need for a WSO. Low altitude night navigation and target ID is inherently difficult and when you factor in the threat arrays that we are forced to penetrate in wartime, the mission success will be very difficult to achieve. You cannot expect a pilot to have his eyes outside of the cockpit 100% of the time. There are too many other duties: radar search, inflight navigation, systems updates, weapons operations, etc. We have gone from a VFR lightweight air-to-air weapons system to a more aerodynamic F-4.

16. F-4 Test Pilot, captain, 26-30 years old with 1300 total hours and no supervisory experience (data not used):

> I have 1050 hours in the F-15 and have had the chance to fly with several WSOs in the initial cadre for the F-15E. I found the workload significantly decreased with an extra man in the cockpit. . . . With AMRAAM coming on line creating multiple target and shoot capability, the workload will increase to the point where formation, visual lookout, etc. will start to breakdown. I think that we will not be able to survive without the WSO. . . . The majority of the times I

have died in engagements it was a direct result of loss of tally on all bandits. Another tactically-minded individual would have increased my chances.

17. F-111 Student Pilot (3 sorties), Captain, 26-30 with 1150 hours and no navigator supervisory experience:

Point 1. We need WSOs, but not necessarily navs. No one will argue that we still need a pilot and WSO in the F-15E and F-111s. The "heavy" B-2, C-17 fly not necessarily a less demanding profile, but by definition/doctrine will fly a more rigidly planned and automated profile--not requiring the expertise and flexibility inherent in having a nav in addition to one or two pilots.

Point 2. Using a "pilot/WSO (right seat of B-2) is a fine idea as long as he is aircraft commander. The idea of a "PSO" (pilot right or back seat of F-111/ F-4) in Vietnam was a flop. Being a pilot (and non-aircraft commander) did not work because they thought they were 2nd class pilots, and fought to get into a real "pilot" slot. The B-2 setup shouldn't have the same problem. I assume the B-2 left seat pilot will move up to the right seat mission commander/WSO with experience.

Point 3. Lumping navs and WSOs in this survey is like comparing apples and oranges. A B-52/B-1 nav sitting in a hole or C-141/C-130 nav is a far cry from a F-15E or F-111 WSO.

Point 4. Despite my arguments for retaining WSOs in TAC, for economic/training reasons I can understand the thought of getting rid of them and using pilots instead. As an OV-10 FAC/ALO I saw an uneven number of WSOs holding down undesirable ALO jobs due to no flying slots available. With 200 F-15E and approximately 150 F-111 (after force cuts) the WSO career field may be too small to support economically.

Point 5. If you start using pilots in WSO positions as mentioned in point 4, expect retention to continue its downward slide. Why be a radar/CRT monitor when I could fly F-16s in the Guard or first officer on a Boeing 757?

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Vita

Major James T. Denney, Jr. [redacted]. After attending several elementary schools throughout the Southeast, he graduated from Anderson County High School in Lawrenceburg, Kentucky in 1969 and received a Bachelor of Arts degree in Biology in 1973. He completed Officer Training School and was commissioned as a second lieutenant on Jan 10, 1979. Major Denney received his wings after completing Undergraduate Navigator Training at Mather AFB CA on Aug 14, 1979. Following Combat Crew Training School at Castle AFB CA, Major Denney was assigned to the 55th Strategic Reconnaissance Wing, Offutt AFB NE, in March 1980. While flying with the 38th SRS, he completed 180 operational reconnaissance missions and served in several positions, including RC-135 Standardization/Evaluation Instructor Navigator. In June 1984, Major Denney was assigned to the 4950th Test Wing, Wright-Patterson AFB OH to become a dual-qualified EC-135/NC-141A research navigator. Before being assigned to AFIT in 1989, he served in the 4950th as the ALCM Operational Test and Evaluation Director, Standardization/Evaluation Chief Navigator, and Wing Executive Officer. Major Denney and his wife, Sally, have four children, Beth, Johanna, Ty, and Daniel.

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13. ABSTRACT (*Maximum 200 words*) This study analyzed the self-reported survey responses of 93 U.S. Air Force pilots concerning their perceptions of the command potential and job satisfaction characteristics of navigators. The first objective of this study was to compare the pilot responses with the results obtained from a previous Job Diagnostics Survey of Air Force navigators and Hackman and Oldham's normative data for professional workers. Differences in pilot attitudes were also compared with those of navigators based on the type of aircraft mission. The second objective was to compare responses based on the pilots' military rank and navigator supervisory experience. The third objective evaluated the pilot's opinion of the continued requirement for navigators in Air Force aircraft and of the ability of experienced navigators to perform as mission commanders. A command potential model was introduced to evaluate the third objective. Conclusions supported the differences in navigator job satisfaction based on aircraft mission. Results of the second and third objectives were inconclusive; although, navigator command potential and the continued need for navigators appear to be higher for tactical airlift and strategic bomber missions. Recommendations for further study and adaptation of the proposed command potential model were presented.

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